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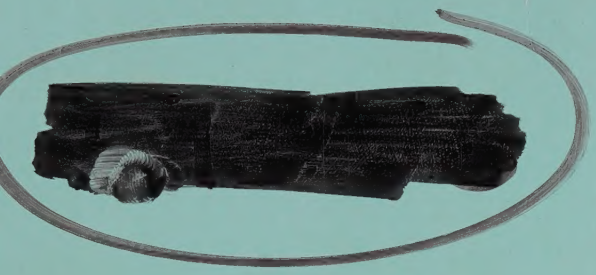
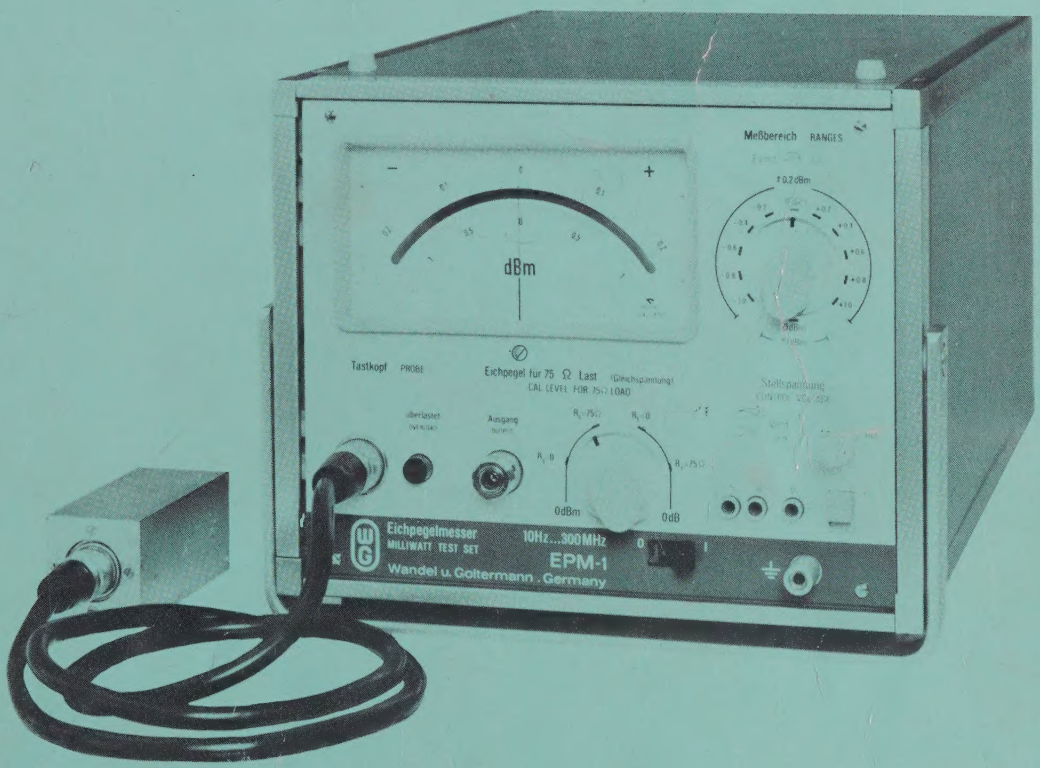
Description and
Operating Manual





Milliwatt Test Set

EPM-1

for the frequency range 10 Hz to 300 MHz

QUALITY ASSURANCE
STANDARDS, CALIBRATION, AND MAINTENANCE LAB.

INST. S.A #71.75.218
CHECK CAL RECORD FOR CHECK OUT.

MILLIWATT TEST SET EPM-1

for the frequency range 10 Hz to 300 MHz

Description and Operating Manual 564 A ...

1 MEASURE THE CAL OUTPUT LEVEL FOR DC mV ACCURACY to ± .00005 mV (± .001 dBm)
2 APPLY POWER HEAD TO CAL OUTPUT, ZERO METER
3 APPLY HP 745 AC CALIB OUTPUT TO POWER HEAD CHECK TO 100 KHz FOR ACCURACY ± .015 dB (±.5 div of scale)
4 CHECK TO 10 MHz USING HP 652 GEN FOR SAME ACCURACY

1.4.72 Loe/Fk
0.2. 4.72 1997

Subject to change without notice

Wandel u. Goltermann · Reutlingen/Germany

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INTRODUCTION

The Milliwatt Test Set EPM-1 is a wide band level meter for the frequency range, 10 Hz to 300 MHz. The main purpose for it is the extremely precise r.m.s. value measurement of the level 0 dBm or 0 dB on transmission systems. Additionally, the level meter can be used for calibrating white noise sources and for verifying the accuracy of calibration of level measuring equipment. Moreover, the level meter can be inserted into a measurement configuration and applied as a constant level amplifier. This application is of great advantage for very accurate measurement of frequency response.

The Test Probe TK-10 is an external part of the EPM-1, and with the Test Probe, the measurement signal can be "picked-up" directly at the chosen circuit point. Thereby, extra connecting cables are eliminated together with consequent attenuation and mismatch effects; thus preventing degradation of results measured at the frequencies of interest. The input impedance is 75 Ω (or 50 Ω).

The wave form of the signal being measured does not affect the measured result because the Milliwatt Test Set measures the heating power of the signal and thus produces a direct correlation with the r.m.s. value of the signal.

The measuring range encompasses - 1 dBm to + 1 dBm. With the use of a switch and an expanded scale, the range can be divided into steps of 0.2 dB. A special circuit protects the measuring thermo-couple from overloads and a visual indication shows an overloaded condition. However, the maximum allowable input voltage must not be exceeded.

Calibration of the EPM-1 is accomplished with an extremely exact d.c. voltage which also is available at an output connector and has either 0 Ω output impedance or 75 Ω (alternatively 50 Ω).

Combined with an accessory "T" connector which has internal termination resistors, the EPM-1 provides the possibility of forming a voltage standard source of $Z_{out} = 75\Omega$ (or 50 Ω) when connected to a signal generator having a d.c. coupled AM input. In this application, a level generator, or a signal generator, and the Milliwatt Test Set form a closed loop stabilizing circuit. Thus, the EPM-1 supplies a d.c. voltage

which corresponds to the difference between nominal level and actual level; this difference voltage,by being applied to the d.c. coupled modulation input, is used to control the signal generator.

The measured result is available at an output for graphic recorders. Due to the handy dimensions and low weight, the Milliwatt Test Set is also suitable to be used as an item of service equipment.

EQUIPMENT MODELS AND ACCESSORIES

Milliwatt Test Set EPM-1	75 Ω	BN 564/0
	50 Ω	BN 564/1
Test Probe TK-10	75 Ω	BN 572/0
	50 Ω	BN 572/1
Accessories by choice:		
Attenuation networks	75 Ω/9.03 dB	BN 594/1
	75 Ω/19.03 dB	BN 594/2
	50 Ω/10.79 dB	BN 594/3
	50 Ω/20.79 dB	BN 594/4
"T" connector	75 Ω	BN 595/1
	50 Ω	BN 595/2
Adaptors		

1. SPECIFICATIONS

All essential characteristics of our instruments are indicated by guaranteed tolerance and limit specifications and not as typical values. They are valid for each instrument not only on delivery but also for the whole guarantee period.

1. TECHNICAL SPECIFICATIONS

When not otherwise given, the values are valid after an operating time of 1 hour for the rated operating range of the power line voltage, the power line frequency and the ambient temperature.

1.1. Frequency range . . . . . d.c., 10 Hz to 300 MHz

1.2. Input (through Test Probe TK-10)

Input impedance, Z, ... 75 Ω or 50 Ω

Return loss coefficient of the input:
- to 50 MHz . . . . . ≦ 0.005
- to 100 MHz . . . . . ≦ 0.01
- to 200 MHz . . . . . ≦ 0.03
- to 300 MHz . . . . . ≦ 0.05

Magnitude, allowable input voltage . . . . . $V_{r.m.s.} = 3$ V

Allowable peak factor of the measurement level . . . . . ≦ 10 [1)]

Overload indication for the thermocouple . . . . . by an indicator lamp

Connecting plugs:
- at Z = 75 Ω . . . . (IEC 75-7) 1.6/10
- at Z = 50 Ω . . . . . N-connector

1.3. Level meter

1.3.1. Measurement range, unexpanded scale . . . . . 0 dBm ± 1 dB
expanded scale . . -1, -0.8, . . . , + 1 dBm ± 0.2 dB

1.3.2. Accuracy of meter readings

1.3.2.1. Accuracy of the scale reading, 0 dBm: in the measurement range, 0 dBm ± 0.2 dB, after calibration, for an ambient temperature (23 ± 3)°C, with consideration for the frequency response curve for each individual Test Probe [2)], for $Z_{out} = Z$ and $Z_{out} = 0$ [3)].

in the frequency range 10 Hz to 50 MHz . . . . . ≦ ± 0.015 dB
and at: 100 MHz . . . . . ≦ ± 0.025 dB
200 MHz . . . . . ≦ ± 0.04 dB
300 MHz . . . . . ≦ ± 0.05 dB

---

1) The peak factor provides the ratio between the peak-value and the r.m.s. value of a voltage.

2) The accuracy of frequency response, referred to 10 Hz, is individually given for every Test Probe at the frequencies: 50, 70, 100, 140, 200, 250 and 300 MHz. Optional "in-between" values can be obtained by interpolation calculations from the known values for accuracy of frequency response or the warranted error limits.

3) The measured values are valid for a cable gradient of 15 mm electrical length placed before the connection interface of the Test Probe. Reference plane is for 1.6/10 and N connector for the common ground contact of the outer conductor.
Error caused by the return loss coefficient does not require additional consideration.

1.3.2.2. Accuracy of the meter reading in the complete level range (expanded or unexpanded):

After calibration in the rated operating range of the ambient temperature, with consideration for the accuracy of frequency response given for every Test Probe [1], for $Z_{out} = Z$ and $Z_{out} = 0$ [2].

in the frequency range 10 Hz to	50 MHz	≦ ± 0.035 dB
and at:	100 MHz	≦ ± 0.045 dB
	200 MHz	≦ ± 0.06 dB
	300 MHz	≦ ± 0.07 dB

1.3.2.3. Frequency response of the meter reading, referred to 10 Hz [1]

with input across $Z_{out} = Z$:	to 50 MHz	≦ ± 0.015 dB
	to 100 MHz	≦ ± 0.035 dB
	to 200 MHz	≦ ± 0,06 dB
	to 300 MHz	≦ ± 0.10 dB
with input across $Z_{out} = 0$ [2]:	to 50 MHz	≦ ± 0.02 dB
	to 100 MHz	≦ ± 0.035 dB
	to 200 MHz	≦ ± 0.12 dB
	to 300 MHz	≦ ± 0.20 dB

1.3.2.4. Influence of equipment temperature on the meter reading . ≦ 0.0015 dB/°C

1.3.2.5. Influence of Test Probe temperature on the meter reading . . ≦ 0.003 dB/°C

1.4. Outputs

1.4.1. Calibrating level output (d.c. voltage)

Selectable calibration level with $Z_{out} = Z$ and $Z_{out} = 0$. 0 dBm across Z and 0 dB

Accuracy of the calibration level at 23 °C . . . . . ≦ ± 0.005 dB

Temperature dependence of the calibration level. . . . . ≦ 0.001 dB/°C

1.4.2. Output voltage for graphic recorder (short circuit proof)

Open circuit voltage, unexpanded . . . . . approx. 0.25 V/0.1 dB

expanded . . . . . approx. 1.25 V/0.1 dB

Output impedance . . . . . 5 kΩ

---

1) The accuracy of frequency response, referred to 10 Hz, is individually given for every Test Probe at the frequencies: 50, 70, 100, 140, 200, 250 and 300 MHz. Optional "in-between" values can be obtained by interpolation calculations from the known values for accuracy of frequency response or the warranted error limits.

2) The measured values are valid for a cable gradient of 15 mm electrical length placed before the connection interface of the Test Probe. Reference plane is for 1.6/10 and N connector for the common ground contact of the outer conductor.
Error caused by the return loss coefficient does not require additional consideration.

1.4.3. Control voltage output for stabilizing a generator
(short circuit proof)

20 to 315mV on SA 3535357903

Adjustable (open circuit voltage)	approx. 30 mV/0.01 dB to 300 mV/0.01 dB
Control range	≧ ± 2 V
Polarity	switchable
Output impedance	approx. 500 Ω

1.5. Ambient temperature

Range for storage and transport	-40 to + 70 °C
Rated operating range	+ 5 to + 40 °C

1.6. Power supply

Rated operating range of the a.c. power line voltages	110/117/127/220/227/235 V -15 %/+ 10 %
Rated operating range of the a.c. power line frequency	45 to 65 Hz
Power consumption	16 VA

1.7. Dimensions

Width	225 mm
Height	220 mm
Depth	370 mm
Weight	7 kg

1.8. Available accessories

1.8.1. Specifications for the attenuation networks
(the values are valid in the operating range for rated temperatures)

Frequency range	0 to 300 MHz

Impedance value/insertion loss for d.c. voltage

BN 594/1	75 Ω/9.03 dB ± 0.15 dB
BN 594/2	75 Ω/19.03 dB ± 0.20 dB
BN 594/3	50 Ω/10.79 dB ± 0.15 dB
BN 594/4	50 Ω/20.79 dB ± 0.20 dB

Frequency response of the insertion loss, referred to d.c.

to 100 MHz	≦ ± 0.01 dB
to 300 MHz	≦ ± 0.03 dB

Return loss coefficient to	100 MHz	≦ 0.01
	300 MHz	≦ 0.03

Largest allowable input:	BN 594/1 and 594/3	0.5 W
	BN 594/2 and 594/4	0.3 W

Plug connectors:	BN 594/1 and 594/2	(IEC 75-7) 1.6/10 (F) - 1.6/10 (M)
	BN 594/3 and 594/4	N-connector (F) -N-connector (M)

Ambient temperature

Range for storage and transport	-40 to + 70 °C
Rated operating range	+ 5 to + 40 °C

1.8.2. Specifications for the "T" network

(the values are valid in the operating range for rated temperature)

Frequency range	0 to 300 MHz

Impedance value:	BN 595/1	75 Ω
	BN 595/2	50 Ω

Voltage difference between both of the outputs when terminated with Z

for d.c. voltage	≦ 0.1 dB
additional to 100 MHz	≦ 0.005 dB
to 300 MHz	≦ 0.01 dB

Maximum loading of resistors	0.25 W

Plug connector:	BN 595/1	(IEC 75-7) 1.6/10 (F)
	BN 595/2	N-connector (F)

Ambient temperature

Range for storage and transport	-40 to + 70 °C
Rated operating range	+ 5 to + 40 °C

1.8.3. Adaptors

			Order number
75 Ω from 1.6/10 (F)	to BNC (M)	(0.02/0.04)	S 391
	to BNC (F)	(0.02/0.04)	S 392
	to 2.5/6 (M)	(0.03/0.05)	S 393
	to 2.5/6 (F)	(0.03/0.05)	S 394
	to 1.6/5.6 (M)	(0.015/0.03)	S 395
	to 1.6/5.6) (F)	(0.015/0.03)	S 396
	to WE 440 A (M)		S 397
	to WE 558 A (F)		S 398
	to WE 358 A (M)		S 399
	to WE 470 C (F)		S 400
50 Ω from N-connector (F)	to BNC (M)	(0.01/0.025)	S 407
	to BNC (F)	(0.01/0.025)	S 408
	to 4.1/9.5 (M)	(0.01/0.01)	S 409
	to 4.1/9.5 (F)	(0.01/0.01)	S 410
	to 7/16 (M)	(0.01/0.01)	S 18
	to 7/16 (F)	(0.01/0.01)	S 17
	to C-conn. (M)	(0.01/0.015)	S 411
	to C-conn. (F)	(0.01/0.015)	S 412

The values given in brackets are the return loss coefficients for the adaptors at 100/300 MHz.

1.8.4. Adaptors - plug to plug

		Order number
75 Ω	1.6/10 (M) - 1.6/10 (M)	S 390
50 Ω	N-conn.(M) - N-conn.(M)	S 406

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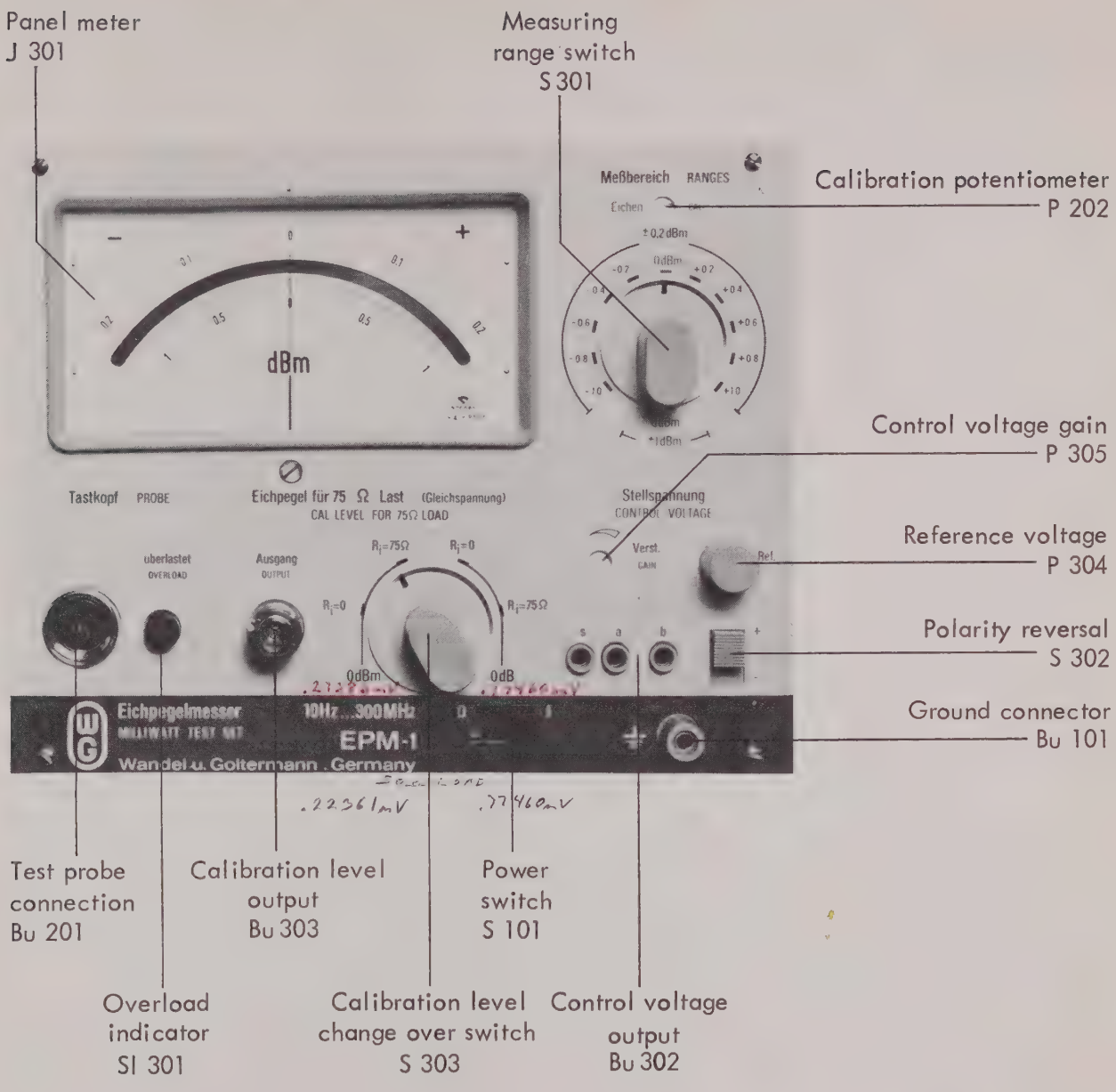
2. OPERATION



Back panel

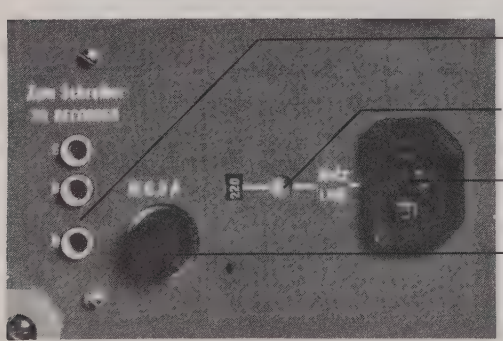


Fig. 2-1

2. OPERATION

In the following description, the shortened adjustment and verification procedure is combined in section 2.4. for those measurements available externally from the cabinet. Only a multimeter is needed for the verification measurements.

2.1. Placing the equipment into operation

The Milliwatt Test Meter EPM-1 is constructed as a bench model. See photograph on title page. A compartment on the back panel contains the a.c. power cable, the test probe and the accompanying connection cable as well as the accessories: "T" connector, attenuation networks, and adaptors.

The EPM-1 can be operated with either the front panel vertical,or the set can be placed at an angle. In order to use it placed at an angle, the bottom feet can be unfolded.

2.1.1. Operating controls

All operating controls and the connectors for: the Test Probe connections, the output connections for calibrating level, and the control voltage connections are arranged on the front panel of the Milliwatt Test Set. The output connector to the graphic recorder is situated on the back panel. The positions of the operating controls are depicted in Fig. 2-1. The Test Probe TK-10 is connected to the EPM-1 by means of the cable delivered with the set.

2.1.2. Connecting the set

Before switching on the set, determine the position of voltage selector switch, S 501, to ensure that it is adjusted for the proper a.c. line voltage. The selector switch is accessible at the back panel of the set. The selected voltage is displayed through a slot. Voltages from 110 V through 235 V can be selected. When changing line voltages, it is not necessary to change the a.c. power line fuse, Si 101, (average blowing speed — 0.5 A) located on the back panel. After the proper a.c. line voltage is selected, the set can be plugged into the a c. line supply. The a.c. power line connector, St 601, is located on the back panel of the EPM-1. As soon as the

on-off switch, S 101, is switched to "I", the equipment is ready to operate. Both the protective conductor of the power cable and the connector to ground, Bu 101, are connected to the chassis.

2.2. Calibrating the Milliwatt Test Set

For calibrating the set, there is an extremely constant d.c. voltage available at the calibrating level output, Bu 303. Calibration level change-over switch, S 303, can be used to adjust the output impedance to be: Z_{out} = 75 Ω (alternatively Z_{out} = 50 Ω) or Z_{out} = 0 for the calibration levels 0 dBm and 0 dB.

When calibrating 0 dBm, the Test Probe is directly connected to calibration level output, Bu 303, and the panel meter is set to zero by using calibrating potentiometer, P 202. Therefore, the meter reading must not change more than ± 0.025 dB when the switch is changed-over between Z_{out} = 75 Ω (alternatively 50 Ω) and Z_{out} = 0 (check the input impedance with d.c.). If the voltage level 0 dB is to be measured at sources with Z_{out} = 0 or Z_{out} = 75 Ω, then a 9.03 dB attenuation network (accessory) must be connected before the Test Probe, and the calibration level change-over switch, S 303, is set to 0 dB and Z_{out} = 0, or alternatively 75 Ω.

For interfacing the Test Set to the voltage level, + 10 dB, an attenuation network of 19.03 dB, which is also available as an accessory, must be screwed on to the Test Probe. With the 50 Ω model, the necessary attenuation networks are of either 10.79 Ω or 20.79 Ω respectively.

2.3. Measuring

The Test Probe TK-10 can be used to "pick-up" the signal directly at the measuring point which is of interest. The TK-10 is connected to the EPM-1 through test probe connector, Bu 201.

With the measurement range switch, S 301, used for the panel meter, the upper scale, expanded, or the lower scale, unexpanded, can be selected. And also, the expanded range can be shifted in steps of 0.2 dB.

2.3.1. Over-load protection

A measurement thermo-couple for picking up measured values is build into the Test Probe. If the thermo-couple is overloaded, then a protective circuit is activated and opens the measuring current circuit: threshold value ≈ 1.7 V. Simultaneously, the over-load is indicated on signal lamp, SL 301. After a waiting period of 1 s, the measuring current circuit closes again. If the over-load condition has persisted, than the action, described above, repeats. However, under no condition, may the maximum allowable input voltage of 3 $V_{r.m.s.}$ be exceeded.

2.3.2. X-Y recorder connection

Recording the measured results can be done on an X-Y recorder connected to "output for recorder", Bu 301, located on the back panel of the equipment. Full scale deflection of panel meter, J 301, corresponds to an output voltage of ≈ ± 2.5 V applied to a recorder.

2.3.3. Control voltage

When operating as a constant level amplifier, the control voltage can be taken from connector, Bu 302. The control voltage is the output from a differential amplifier, the gain of which is adjusted with potentiometer, P 305. Potentiometer, P 304, varies the magnitude of the reference voltage at the second input of the differential amplifier. Switch, S 302, is a polarity reversal switch.

2.4. Checking the function

Connect the equipment

Select a.c. power line voltage with selector switch, S 501. Selected voltage scale reading can be seen in slit.

Plug a.c. power cable into power line connector, St 601.

ON-OFF switch, S 101, placed in "I" position. Instrument ~~pilot~~ METER lamp is lit.

If pilot lamp is not lit, check fuse, Si 101.

If Test Probe TK-10 is not connected, pointer on panel meter, J 301, is at full scale deflection at right hand stop and over-load indicator, SL 301, is on continuously.

If the TK-10 is connected, pointer of J 301 is at left stop. Overload indicator, J 301, lights only for a short time.

Calibration

Test Probe TK-10 connected to test probe input, Bu 201, by means of connection cable.

For power level measurements, Test Probe TK-10 is directly plugged into calibration level output, Bu 303. $Z_{out} = 0$ or $Z_{out} = Z$ for 0 dBm with calibration level switch, S 303, switched in.

For voltage level measurements, Test Probe TK-10 is connected through an attenuation network to the calibration level output.

For the 75 Ω model, attenuation network is 9.03 dB; for the 50 Ω model, attenuation network is 10.79 dB. $Z_{out} = 0$ or $Z_{out} = Z$ for 0 dB with calibration level switch, S 303, switched in.

Calibration level, 0 dBm, is adjusted with measurement range switch, S 301. Set meter pointer to 0 by using potentiometer, P 202.

Measuring

Connect Test Probe TK-10 to test object (if necessary use adaptor). Set measurement range with switch, S 301.

Attention! If measurement thermocouple is overloaded, SI 301, the overload indicator, is lit. Measuring current circuit is disconnected, and after a waiting time of 1 s is re-connected. The maximum allowable input voltage of $V_{r.m.s.} = 3$ V must not be exceeded.

Checking X-Y recorder connection

Test Probe TK-10 plugged into calibration level output, Bu 303. $Z_{out} = 0$ or $Z_{out} = Z$ for 0 dBm; switched with calibration level switch, S 303.

Calibration level 0 dBm adjusted with measurement range switch, S 301, and panel meter set to 0 with potentiometer, P 202.

Multimeter (100 kΩ/V) connected to recorder output, Bu 301.

Measurement range switch, S 301, adjusted according to table. Panel meter, J 301, reads + or - at left or right stop.

Read measured value on multimeter.

Checking of	Setting S 301	S 301	Measured value
recorder voltage	-0.2 dBm	+ full scale deflection	≈ + 2.5 V
	+0.2 dBm	- full scale deflection	≈ - 2.5 V

Verifying control voltage

Connect Test Probe TK-10 to calibration level output, Bu 303.

$Z_{out} = 0$ or $Z_{out} = Z$ for 0 dBm; selected with calibration level switch.

Calibration level 0 dBm adjusted with measurement range switch, S 301, and panel meter set to 0 with potentiometer, P 202.

Multimeter (100 kΩ/V) connected to control voltage output, Bu 302. Connect + of multimeter to point a of Bu 302 and - of multimeter to point b of Bu 302.

According to the table, adjust: reference voltage with P 304, gain with P 305, measurement range with S 301 and polarity with S 302.

Checking of	Setting P 304	P 305	S 301	S 302	Measured value
Reference voltage	right	right	0 dBm	+	≈ 2.8 V
	left	left	0 dBm	-	≈ 2.8 V
Gain	right	right	0 dBm	+	≈ 2.8 V
	right	left	0 dBm	+	≈ 0.6 V
	left	right	0 dBm	-	≈ 2.8 V
	left	left	0 dBm	-	≈ 0.6 V
Control range	centre (0 V)	right	+ 0.2 dBm	+	≈ 2.8 V
	centre (0 V)	right	- 0.2 dBm	-	≈ 2.8 V

3. TECHNOLOGICAL INSTRUCTIONS

3. TECHNICAL INFORMATION

3.1. Influence of the frequency response on the measuring accuracy of the TK-10

3.1.1. Tabulated measurement specifications

Every Test Probe TK-10 is delivered with an individual table of specifications prepared at the factory. This table of measurement specifications ensures an accurate survey of the particular frequency response for that Test Probe.

As an example, a table of specifications is reproduced here:

Probe TK-10
BN 572
Wandel u. Goltermann - Reutlingen
Z = 75 Ω SERIAL NO. XY.....

SPECIFICATIONS (GUARANTEED)

FREQUENCY	FREQUENCY RESPONSE WITH SOURCE IMPEDANCE OF:	
	$Z_{out} = Z$	$Z_{out} = 0$
10 Hz ... 50 MHz	≦ ±0.015 dB	≦ ±0.02 dB
10 Hz ... 100 MHz	≦ ±0.035 dB	≦ ±0.035 dB
10 Hz ... 300 MHz	≦ ±0.1 dB	≦ ±0.2 dB

Fig. 3-1 Obverse side of table of specifications

REPORT OF CALIBRATION

FREQUENCY	FREQUENCY RESPONSE WITH SOURCE IMPEDANCE OF:		UNCERTAINTY OF CALIBRATION
	$Z_{out} = Z$	$Z_{out} = 0$	
50 MHz	+ 0.005 dB	− 0.005 dB	0.010 dB
70 MHz	+ 0.008 dB	− 0.012 dB	0.015 dB
100 MHz	+ 0.010 dB	− 0.015 dB	0.015 dB
140 MHz	+ 0.015 dB	− 0.018 dB	0.020 dB
200 MHz	+ 0.020 dB	− 0.022 dB	0.030 dB
250 MHz	+ 0.005 dB	− 0.007 dB	0.035 dB
300 MHz	− 0.050 dB	+ 0.010 dB	0.040 dB

DATE 10.2.72 NAME Funck

Fig. 3-2 Reverse side of table of specifications

With the aid of the table of measurements, it is possible to accurately define any error in frequency response, and thereby increase the measurement accuracy.

If measurements are made between the points of frequency settings, then linear interpolation of values is sufficiently accurate. See Fig. 3-3.

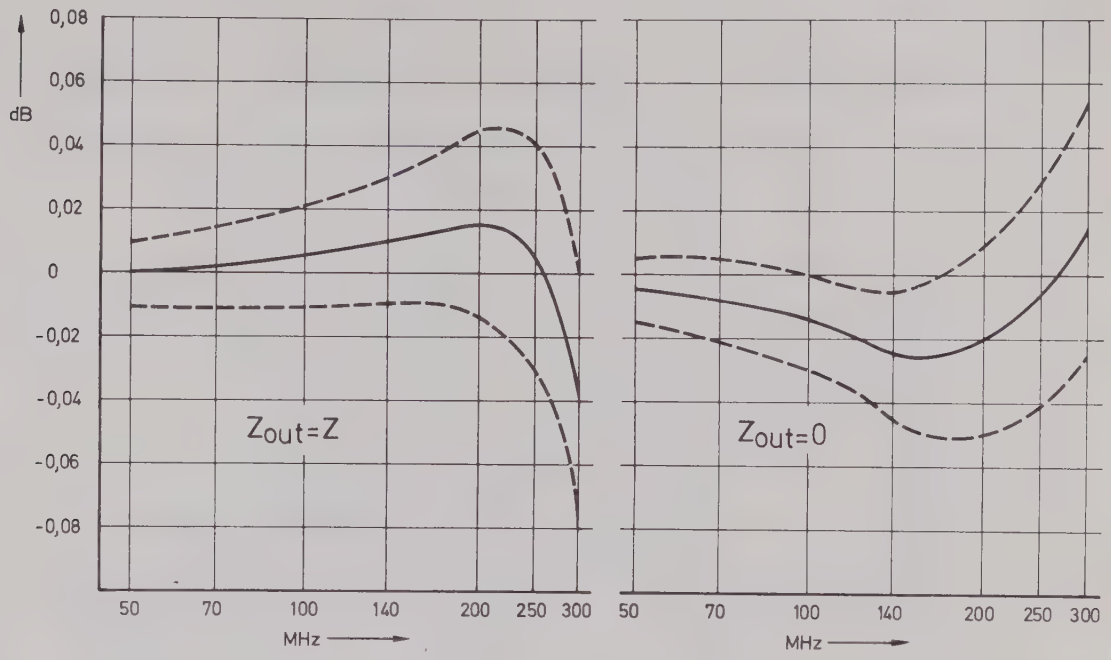


Fig. 3-3 Typical frequency response referred to 10 Hz (unbroken line) with accuracy of measured values (broken line)

3.1.2. Example of use of table of measurements specifications

Example 1:

A measurement shall be made at 100 MHz, Z_{out} = 75 Ω. On the panel meter, the indicated value is + 15 dBm. This indicated value includes an error in frequency response. In the tabulation, at 100 MHz, there is listed an error of + 0.01 dB (Fig. 3-2), i.e., the indicated value on the meter is 0.01 dB too high. For achieving the true measured value, 0.01 dB must be subtracted from the meter reading.

Indicated value	+ 0.15 dBm
Frequency response error	- (+ 0.01 dB)
True value	= + 0.14 dBm

For this calculated true value, there is a warranted error value limited to be ≦ ±0.045 dB at 100 MHz. (See section 1.3.2.2. indicated error). And within these limits of error, there is inclusion of the uncertainty of the measured values according to Fig. 3-2. However, if the frequency response error is not observed and remains uncorrected, then the limits of error are larger for the frequency response error of the Test Probe, and, in fact, have an adverse effect on the measuring accuracy.

Example 2:

At 300 MHz and Z_{out} = 75 Ω, 0 dBm shall be the reading on the panel meter. The ambient temperature shall be (23 ± 3) °C.

From the table of measurements, Fig. 3-2, it is seen that the error in frequency response at 300 MHz is - 0.05 dB, i.e., the meter reading is 0.05 dB too low. In order to achieve the nominal value of 0 dBm, the panel meter must have a level reading of - 0.05 dBm.

Nominal value	0 dBm
Frequency response error	+ (- 0.05 dB)
Value to be set at	= - 0.05 dBm

For 0 dBm and an ambient temperature of (23 ± 3) °C, the warranted error limits are ≦ ± 0.05 at 300 MHz (see section 1.3.2.1. meter reading error). Within these error limits, the uncertainty of the measured value is already included according to Fig. 3-2. If the frequency response error is not observed and no correction is made, then the limits of error are higher for the frequency response error of the Test Probe. And at higher frequencies, these cause a degradation of measuring accuracy.

3.2. Influence of temperature on the accuracy of measurements

If the temperature of the Test Probe changes by 1 ° after calibration, then the reading can be in error by ≦ 0.003 dB. If the temperature of the equipment, itself, changes by 1 °C, then the reading can be in error by ≦ 0.0015 dB.

When a high accuracy of measurement is required, then the ambient temperature must be held as constant as possible. Therefore, the Test Probe is to be protected from ex-

ternal warming effects, e.g., sun rays or direct contact with an equipment which is radiating heat. Also, the temperature of the EPM-1 can be changed by placing it too close to another equipment which is warm.

3.3. Influence of the output impedance ($Z_{out}=Z$ or $Z_{out}=0$) on a measurement

The input impedance of the Test Probe TK-10 is made up from a network of parallel resistors and a thermocouple with series resistance added. Thus, the complete input power is not applied to the thermocouple. Due to this reason, the frequency response of the Test Probe as well as the frequency response of the return loss coefficient are also dependent upon the frequency response of the network.

When being fed by $Z_{out} = Z$, the return loss coefficient adds a quadratic function to the measurement error. For this reason, the error of this mode predominates over that error caused by frequency response. However, this is only 0.05 dB at 300 MHz! When being fed by $Z_{out} = 0$, that is, with a constant voltage generator, the return-loss coefficient causes a proportional effect, and therefore is a measure of the achievable measurement accuracy.

The influence of the return-loss coefficient can be eliminated on measurements with direct current and with low frequencies because the Test Probe can be calibrated for the choice of either $Z_{out} = Z$ or $Z_{out} = 0$ by using the internal source for calibration.

A statement of the frequency dependent individual error does not have any practical advantage. Moreover, in the Chapter, "Technical Specifications", the total error for both modes, $Z_{out} = Z$ and $Z_{out} = 0$ is given.

For operation with $Z_{out} = 0$, the warranted frequency response is strictly valid only for constant voltage drop in the input cable (a length of 15 mm before the connection point of the Test Probe, see pp, 1-1 and 1-2).

For input cables of any length longer than 15 mm before the connection point at the Test Probe proper, there is a larger frequency response error to consider due to dependence upon frequency and cable length. For the worst case, the error can achieve the magnitude of the return loss coefficient.

3.4. Application as constant level amplifier

The Milliwatt Test Set EPM-1 can be used as a constant level amplifier. This is accomplished by forming a closed loop control circuit with a level generator or a signal generator and the EPM-1.

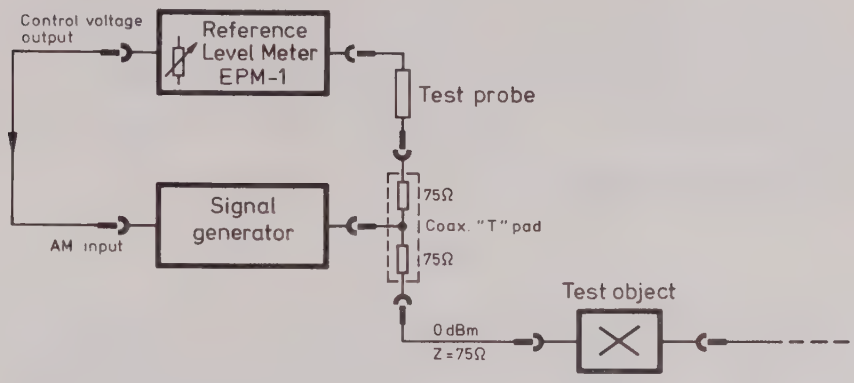


Fig. 3-4

By means of a "T" branch connection (an accessory), the test object and the Milliwatt Test Set are fed the same amount of power. The control voltage output of the EPM-1 is connected to the AM input of the signal generator. However, as a prerequisite, the signal generator must have either a d.c. voltage coupled AM input or a control voltage input. This prerequisite is fulfilled by Level Generator PS-5, PS-6, PS-7 or Signal Generator MG-164.

The EPM-1 provides a control voltage which corresponds to the difference between nominal and actual level and which is applied to the modulation input of a generator. Therefore, the output power of the generator is held constant and is independent of the selected frequency with the exception of the error caused by the Test Probe (order of 10^{-3}). The frequency response error of the signal generator is nearly completely held at a constant level. Moreover, the error is eliminated for the output impedance in the generator. The magnitude of generator level can be adjusted very accurtely by changing the reference voltage with potentiometer, P 304, on the EPM-1.

If output voltages of 0 dB or + 10 dB from a generator are to be held constant, then the level interfacing before the Test Probe must be correspondingly adjusted by connecting the proper attenuation network (see section 2.2.).

Any hum voltage lying between the chassis of the EPM-1 and the chassis of the generator being controlled can be transferred to the AM input of the generator. A direct connection between the two chasses could cause this to occur, and as a result, the generator signal would be modulated. Thus, the hum voltage would appear as modulation of the level output of the generator.

In order to hold this possible error to a minimum value, the cable resistance of approx. 1 Ω, as seen in Fig. 3-5, is decoupled by the addition of a 100 Ω resistor connected in series. And by this method, the hum voltage is reduced to approx. 1 % at the control voltage output.

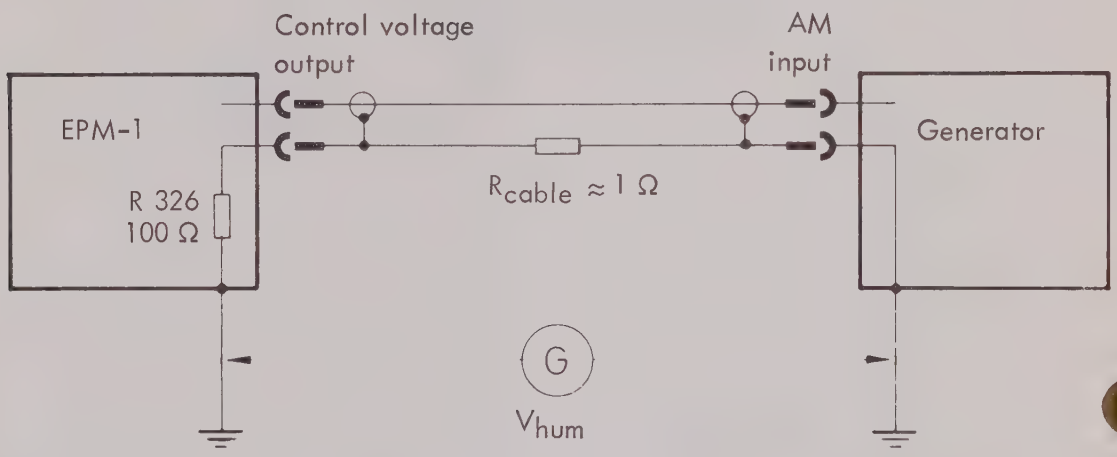


Fig. 3-5

3.5. Frequency response measurements

Using two Milliwatt Test Sets EPM-1, an accurate frequency response measurement can be made. Fig. 3-6 illustrates an arrangement for graphically recording frequency response.

Thus, one EPM-1 is used as a constant level amplifier, and the additional EPM-1 is used for measuring the output power from the test object. The X-Y recorder receives two input signals; one input from the recorder output of the first EPM-1 for the vertical deflection of the X-Y recorder, and the second input is directly from the wobbulator output of the signal generator for the horizontal deflection.

When using a swept frequency, not only the EPM-1 must have a time constant with the order of 1 s, but also the X-Y recorder must have that time constant.

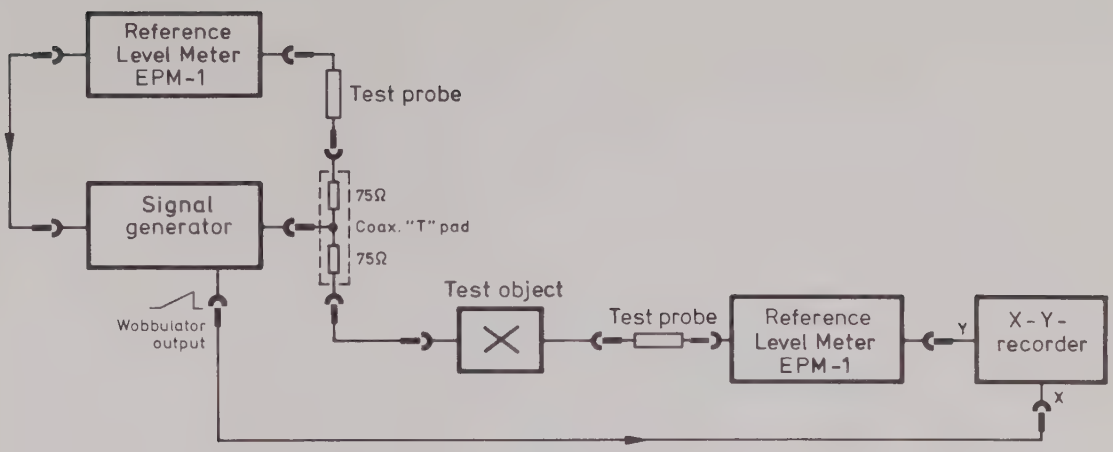


Fig. 3-6

The sweep rate can be verified with the following method: when the selected sweep rate is divided by two, changes in the frequency response of the controlled generator must not be greater then those within the measuring accuracy.

4. DESIGN DETAILS AND CHARACTERISTICS

4. FUNCTIONS AND CHARACTERISTICS

The EPM-1 is a wide band level meter for the frequency range 10 Hz to 300 MHz, and it is used for extremely exact measurements of the levels 0 dBm or 0 dB.

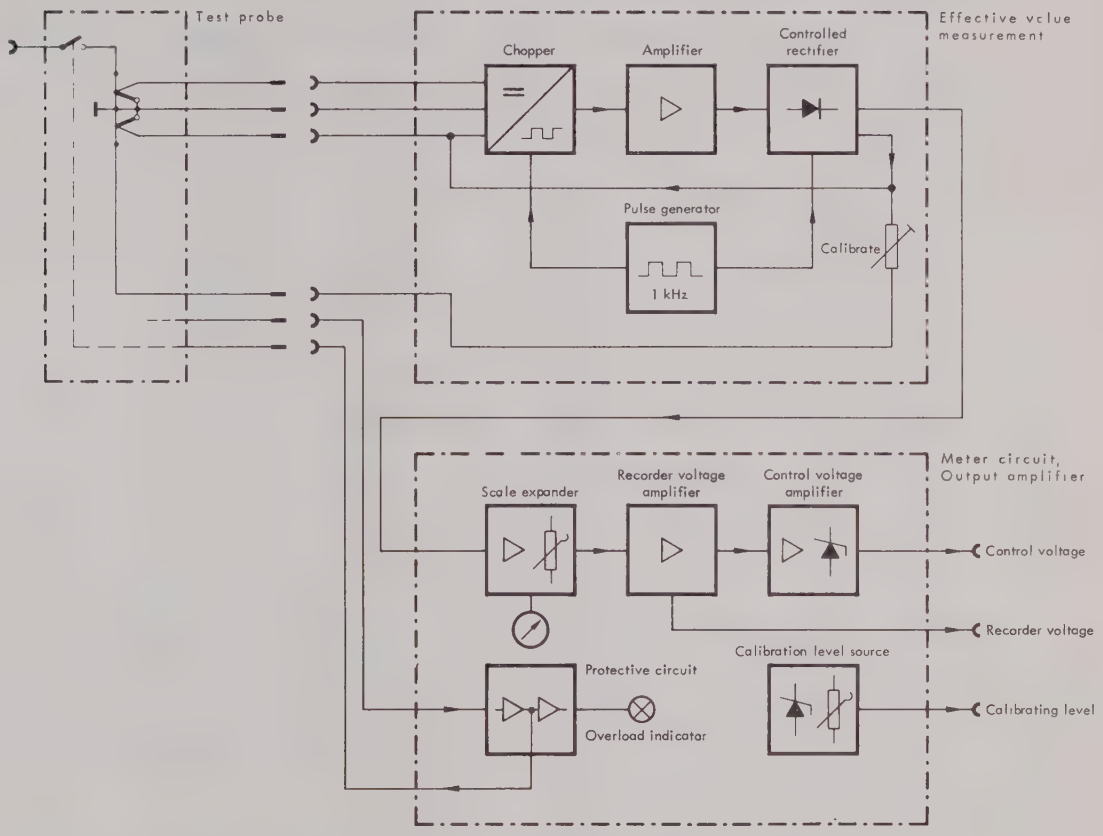


Fig. 4-1 Simplified Block Diagram

4.1. Test probe

With the Test Probe TK-10, the signal being measured is picked-up directly at the measurement point of interest. The thermo-couple contained within the Test Probe measures the heating power of the signal being measured. Thus, the wave form of the input signal has no effect on the measured result. The Milliwatt Test Set always measures the true r.m.s. value of the input signal. Since the transducer is directly within the Test Probe, auxiliary cables are not required with the considerable attendant attenuation and false voltage influences on the measurements within the available

frequency range. The temperature dependence of the measuring thermo-couple is compensated by a reference thermo-couple placed adjacent to the measuring thermo-couple in the Test Probe.

4.2. R.M.S. value measuring

The measuring thermo-couple in combination with the chopper, the chopper amplifier, and the controlled rectifier forms a closed loop control circuit which reacts to the difference between the two thermal voltages.

Both thermal voltages are connected in opposition to each other, and they are alternately applied to the input of the chopper amplifier. The difference between the two voltages is amplified and evaluated by a controlled rectifier.

The d.c. voltage at the output of the controlled rectifier is fed back to the reference thermo-couple, and the resulting change tends to balance out the difference of voltages so as to cause zero difference. If the voltage at the measuring thermo-couple changes, then a proportional voltage change occurs at the output of the rectifier. The rectifier output voltage can be directly applied to the panel meter. A simultaneous and equal change of measuring and reference thermal voltages does not cause a change in the output voltage of the rectifier, and also it is not indicated. By this method, the temperature dependence of the measuring thermo-couple is compensated through a wide range.

The chopper and the controlled rectifier are synchronized by an internal clock pulse generator having a frequency of 1 kHz.

4.3. Panel meter circuit and output amplifier

The meter scale expansion and the switching to various measuring ranges is done in the scale expander circuit. The panel meter indicates the r.m.s. value of the measuring signal.

The voltage amplifier for driving the recorder produces a d.c. voltage which is proportional to the meter indication and is used for controlling an X-Y recorder.

When operating as a constant level amplifier: the measured voltage is applied to one input of a differential amplifier which has an adjustable reference voltage applied to the second input. From the output of this amplifier, the control voltage is picked-up for the controlled signal generator.

For calibrating the Test Set, a calibrating voltage is generated. The extremely constant d.c. voltage is derived from a silicon reference element.

The protective circuit opens the measuring current circuit if the measuring thermo-couple is overloaded.

5. MAINTENANCE AND GENERAL INFORMATION

5. MAINTENANCE AND GENERAL INFORMATION

Attention: Before opening the equipment, ensure that the power line plug has been removed.

5.1. Mechanical disassembly

The dimensions of the cabinet correspond to the new DIN Norm 41 494 as well as to the American Standard ASA C 93.9. The equipment can therefore be mounted into a 19inch rack. See section 5.4. Cover, bottom plate, back panel and side panels are fabricated from sheet aluminium which is plastic coated on one surface. After loosening the corresponding screws on the back panel of the equipment, removing the side panels is done by pulling the panels backwards away from the cabinet. This provides access to the switch and circuit components.

5.2. Care of switch

For preventing mechanical wear of the dB step switch, the indents should be regularly lubricated with switch grease.

5.3. Changing fuses

The a.c. power line fuse, Si 101, is easily accessible at the back panel. The same value fuse (M 0.5 A) is used for all power line voltages.

5.4. Mounting in 19inch rack

If the equipment is to be used in a 19" rack, then an empty cabinet or an equally wide second equipment must be used as a space filler. It does not affect operation if the empty cabinet is placed either to the left or to the right of the EPM-1 in the rack.

For combining two half-size cabinets, the following tasks are required:

Unscrew carrying handle

Unscrew: corner pieces right, or alternatively left, upper and lower together with the plastic spacers. See Fig. 5-1

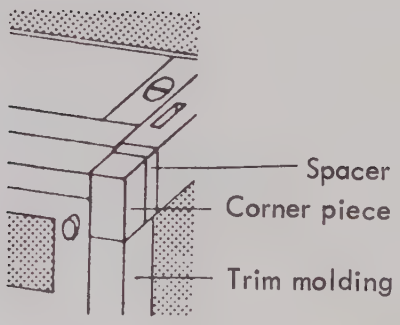


Fig. 5-1

Cover and bottom plate as well as both side panels pulled to the back. Remove guide studs and foot bars from cover and bottom plate respectively. See Fig. 5-2

Unscrew right, or alternatively left, parts of the trim molding and screw on right, or alternatively left, carrying handle See Fig. 5-2

Replace and refasten trim molding (left or right).

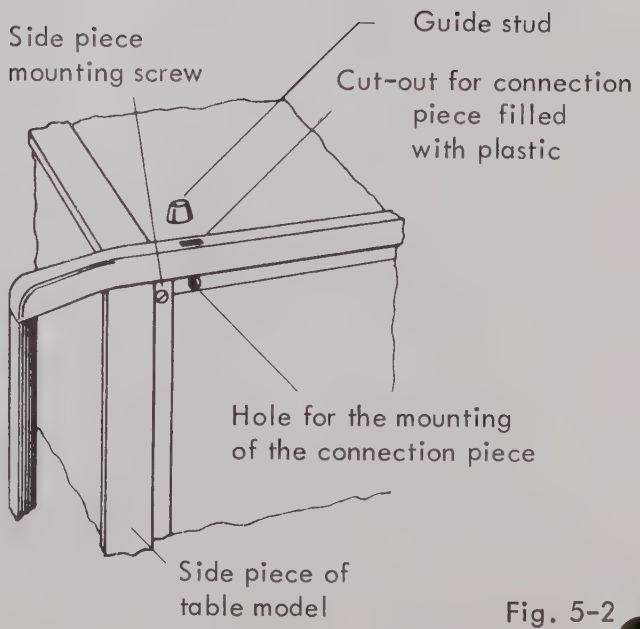

Side piece mounting screw
Guide stud
Cut-out for connection piece filled with plastic
Hole for the mounting of the connection piece
Side piece of table model

Fig. 5-2

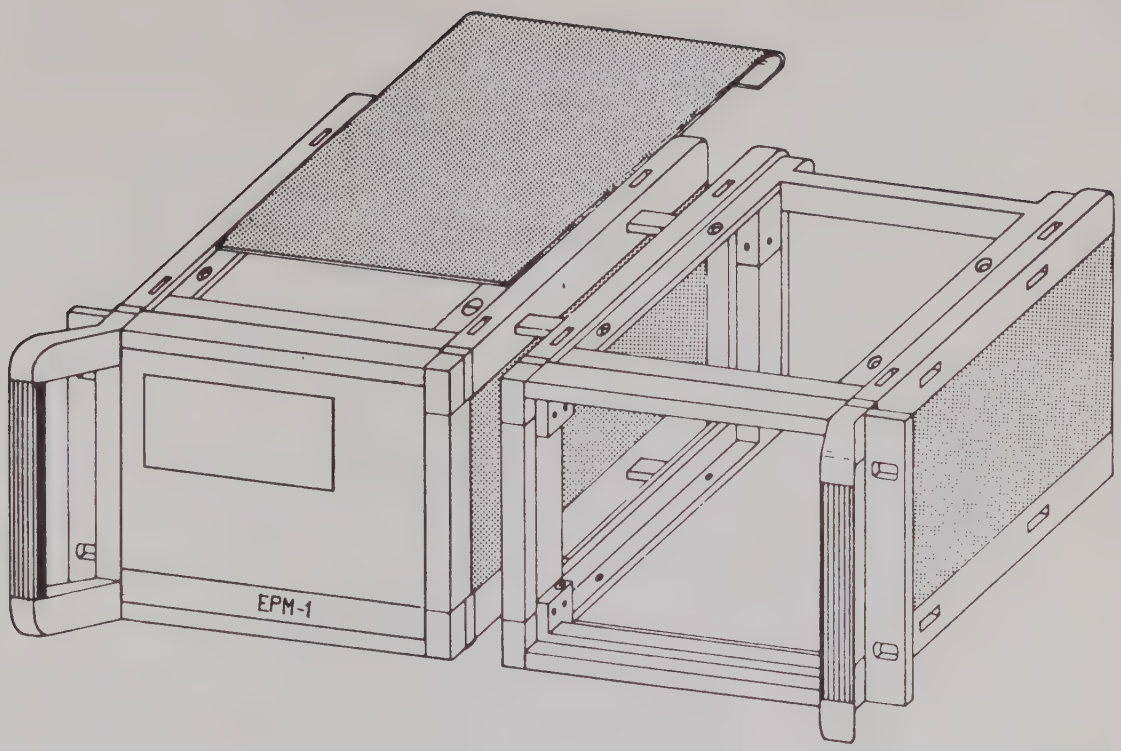


Fig. 5-3

Four side fasteners, approx. 34 mm long for 1/2 width of 19 inch wide, order number 00-0430.14/5 (see Fig. 5-3). The fasteners are inserted into the prepared slots and screwed to the cabinets.

Left, or alternatively right, trim molding of the EPM-1 replaced by a mounting angle BN 556/4.

Cover and bottom plate as well as left, or alternatively right, side panel replaced.

Remove the side panels, cover and bottom plate of the empty cabinet by pulling panels to the rear direction, and remove guide studs and foot. Place side fasteners into the slots in the frames and screw together as shown in Fig. 5-3.

First remove the trim molding, then the handles and mounting angles are screwed on.

Left, or alternatively right, panel of the EPM and right, or alternatively left, panel of the empty cabinet as well as both cover and bottom plates are replaced.

On the second equipment, the left, or alternatively the right equipment panel is correspondingly fitted.

Both equipments are fastened together at the sides by the 4 link fasteners.

Mounting angle fastened to EPM-1 and second equipment.

Both equipments restored to normal.

5.5. Combining several equipments

When necessary, bench models can be placed one upon the other because of being able to mate the guide studs on the cover of the bottom unit of equipment with the holes in the foot bars of the upper unit of equipment.

For long periods of operation, the equipments can be fastened together by 4 vertical fastenings, each approx. 41 mm long, order number BN 00-0400.06/5. For this method of fastening, it is necessary to remove both the cover of the lower equipment and the bottom plate of the upper equipment. And the side panels are removed from both equipments. Next the plastic plugs are pushed out (knock-out plugs), and then the four fasteners are inserted through the four slots corresponding to the pushed out plastic plugs of the cover cabinet. Then each of the 4 fasteners are secured by 4 screws being screwed into the lower cabinet. See Fig. 5-4. After the guide studs on the cover plate and the foot bars on the bottom plate are removed, both plates can be replaced. Now, the two equipments are positioned so that in the frame of the upper equipment, the slots pass through the fasteners projecting from the lower equipment. After screwing the fasteners to the upper equipment, the side panels can be replaced.

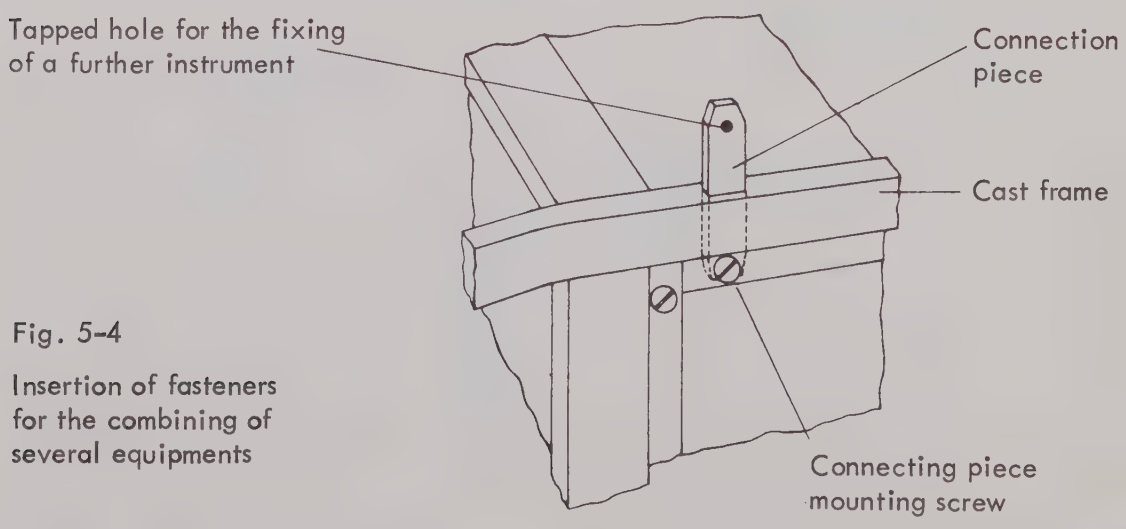


Fig. 5-4

Insertion of fasteners for the combining of several equipments

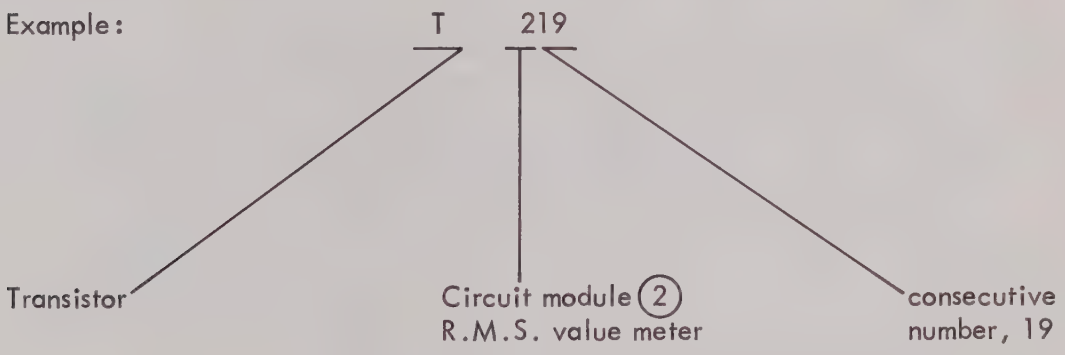
6. NOTES REGARDING THE SERVICE MANUAL

6. NOTES REGARDING THE SERVICE MANUAL

The following paragraphs explain the abbreviations, symbols and drawings.

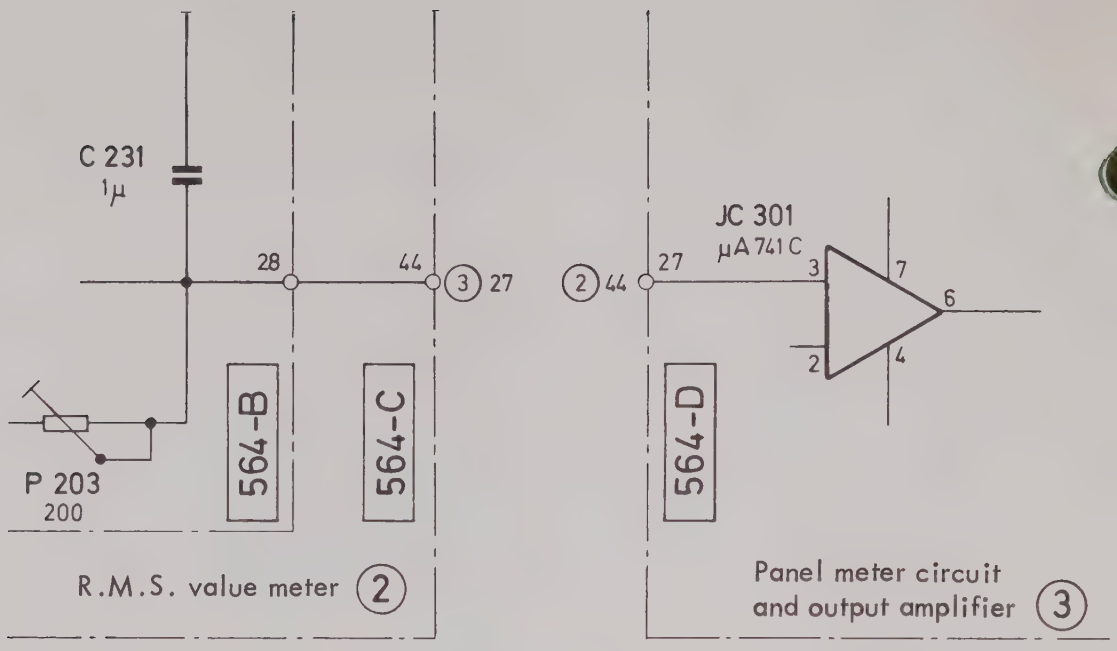
6.1. Circuit components-key

The individual circuit modules are identified by their respective numbers. For example, (2) r.m.s. value meter. The position numbers of all circuit components used in this circuit module begin with the number, "2". Both of the succeeding numbers indicate the consecutive number of the component, e.g. 01 in resistor, R 210, or 23 in capacitor, C 223. That letter used as the first in the identification group of symbols is the letter corresponding to the circuit component. See section 6.3.



6.2. Connecting circuit modules

Since the circuit diagrams in the appendix are presented separately for each circuit module, all interconnections must be clearly identified. The following sketch explains the method as practiced for designating the connections.



The sketch illustrates a connection from circuit module (2) point 44 to circuit module (3) point 27. The circuit components of the r.m.s. value meter (2) are assembled onto printed circuit boards [564-A] and [564-B], both of which are plugged into mounting card [564-C].

6.3. Abbreviations and symbols

In order to achieve a greater simplicity, the following abbreviations and symbols have been used in the text:

Battery	B	Quartz crystal	Q	
Socket	Bu	Relay	Rel	
Diode, rectifier	Gl	Relay contact	rel	
Zener diode		Switch	S	
Varactor diode		Fuse	Si	
Inductance	L	Control lamp	SL	
Meter	J	Transistor	T	
Capacitor	C	Transformer	Ü	
Potentiometer	P	Resistor	R	
		Thermistor		

6.4. Color code

Resistor and capacitor coding

Colour	1st + 2nd point	3rd point	4th point	5th point [1]
	1st + 2nd digit	Number of zeros	Tolerances %	Operating Voltage in V
black	0	0	-	-
brown	1	1	1	100
red	2	2	2	200
orange	3	3	3	300
yellow	4	4	4	400
green	5	5	5	500
blue	6	6	6	600
violet	7	7	7	700
grey	8	8	8	800
white	9	9	9	900
gold		x 0.1 [2]	5	1000
silver		x 0.01 [2]	10	2000
without colour			20	500

1) Only for capacitors
2) Multiplier for values below 10

47000 Ω ± 10 %

Yellow violet orange silver

Abbreviations of connection lead colours

bl	blue
blank	barewire
br	brown
fl	transparent
ge	yellow
gn	green
gr	grey
rs	pink
rt	red
Schirm	screened
sw	black
vio	violet
ws	white
wsbl	white/blue
wsbr	white/brown

6.5. Notes for the circuit diagrams

All indicated voltages are mesured to the chassis with a 100 kΩ/V meter. Encircled figures designate circuit modules and circuit diagrams, framed figures and letters identify printed circuit boards. Test points are indicated with "TP" together with a consecutive number.

Example: (3) = circuit diagram 3

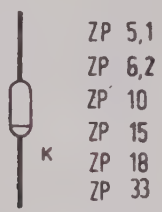
[564-D] = printed circuit board, D

TP 201 = test point, 201 (in circuit diagram 2; test point 01)

6.5.1. Power ratings of resistors

Resistors are rated in W or the value designations according to DIN 44 050 are given in component parts lists.

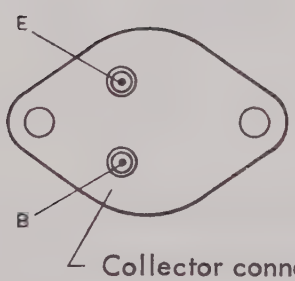
6.5.2. Electrode identification for diodes, transistors, and integrated circuits



BCY 59 D
BFX 93
BSX 52 A
DW 7154
2 N 3251
MEL-11

BPY 60
2 N 2905
BFX 68A

BF 245 A



2 N 3055

µA 741 C

6.6. Information for ordering repair parts

The most important facts about required spare parts can be obtained from the component parts lists. Components with Bv. or WN designation numbers are to be ordered from the factory. When ordering repair parts, it is important to provide the equipment serial number after the BN order number, and, as well, the position number of the component.

Example: BN 564/ No. 420 351 A/ Ü 101

7. CIRCUIT DESCRIPTION

the clock-pulse generator. See 7.2.3. For balancing the inequalities between T 201 and T 202, there is individual equalization of the switching voltages by means of adjustable collector resistances, P 204 and P 205, in the clock pulse generator.

Matching transformer, Ü 201, increases the signal-to-noise ratio. For the same reason, the band width of the chopper amplifier is limited by having a lower cut-off frequency of f_l = 300 Hz and an upper cut-off frequency of f_u = 3 kHz.

The input stage of the chopper amplifier includes an FET, T 203. Transistors, T 206 and T 207 are used for phase reversal. Impedance matching for the resulting signals in phase opposition is done by common collector stages, T 209 and T 211, which are preceeded by T 208 and T 210 for increasing the input impedance. C 221 and C 222 couple-out the signals and feed the controlled rectifier.

7.2.2. Controlled rectifier

The controlled rectifier both evaluates the output signal of the chopper amplifier and provides information to the reference thermo-couple.

The utilized signal in phase opposition from the output of the chopper amplifier controls transistors, T 214 and T 216, while the clock pulse generator switches transistors, T 215 and T 217. The on-off cycle causes a corresponding simultaneous duty cycle of the rectifier. The integrator, C 228, provides a positive d.c. voltage which is dependent upon the utilized signal. To prevent the reference thermo-couple from being overloaded, the Zener diode, Gl 204, limits the output voltage of the rectifier to $\approx$ 5.6 V.

With P 202 and P 203,the nominal current in the reference current circuit is adjusted for the output voltage from the rectifier, a voltage corresponding to 0 dBm on the panel meter. Therefore, by using P 203, a one time alignment ia afforded which balances the tolerances of the scale expander circuit.

P 202 is fastened to the front panel and is externally accessible. With this potentiometer, stray effects can be balanced out when Test Probes are exchanged or values change due to ageing, etc. thus compensation is provided for the attenuation error in the attenuation networks;to be added in with the measurement of the level, 0 dB.

7.2.3. Clock pulse generator

The free running multivibrator, T 212–T 213, generates pulses with a pulse-to-space ratio of 2: 1 and a frequency of 1 kHz. The differential amplifier, T 218 and T 220, is connected after the flip-flop stage and forms the pulses. The switching voltages for the chopper are taken from across P 204 and P 205. Constant current source, transistor stage, T 219, supplies current to the differential amplifier.

Due to the delay of the utilized signal within the chopper amplifier, a phase shift occurs between the utilized signal and the switching signal. This phase shift is equalized by delay network, P 206 and C 232.

The Schmitt trigger, T 221-T 222, switches the controlled rectifier. The pulse-to-space ratio can be adjusted with P 207.

7.3. Panel meter circuit and output amplifier, BN 564 (3)

7.3.1. Scale expander circuit

IC 302, T 301 and T 302 form a constant current source which furnishes a current of 16.5 mA to the divider, R 306 to R 316. At the taps of this divider, d.c. voltages are available with values required for each of the zero readings in the respective measurement ranges.

The voltage tap in use at the time is connected by S 301 to the minus input of the operational amplifier, IC 301. At the minus input, there is the voltage delivered by the controlled rectifier and that voltage is proportional to the voltage being measured.

If the voltages are of equal magnitude at both inputs, the plus input as well as the minus input, then no current flows through the meter circuit, and the panel meter reads "zero". However, if there is a difference between the two voltages, the IC 301 drives current through the meter circuit and the voltage divider, R 306 to R 316. In the the divider, this driver current is added or subtracted from the constant current. Therefore, the voltage changes at the divider taps and at the minus input of IC 301. That causes stabilization of the meter circuit.

The meter circuit is made from a combination of resistors and the panel meter, J 301. Resistor, R 302, and potentiometer, P 302, limit the meter current to the maximum

allowable value. R 303 and P 303 serve as by-pass resistors for the meter movement in the range, 0 dBm ± 0.2 dBm. In the range, 0 dBm ± 1 dBm, additional resistors, R 301 and P 301, are connected as by-pass resistors. The panel meter, J 301, is calibrated with P 301 and P 303.

7.3.2. Graphic recorder voltage amplifier

The voltage for the X-Y recorder is tapped-off R 302 and P 302. This voltage is zero at a reading of 0 dBm, and at full deflection, the voltage is 8.31 V. The tapped-off voltage is applied to the plus inputs of IC 303 and IC 304. Integrated circuit, IC 303, is used as a buffer stage with unity gain, and IC 304 amplifies the input voltage by a factor of 0.3. At the X-Y recorder output, there is a voltage of ± 2.5 V for full scale deflection of the panel meter.

This output voltage is adjustable with P 302 and it has the same polarity as the indication of the meter. A very small difference exists between the values of voltage at plus direction full scale deflection or minus direction full scale deflection because the panel meter does not require as much driving current for the minus direction full scale deflection.

7.3.3. Control voltage amplifier

The output voltage of the X-Y recorder amplifier is connected by way of IC 305 and S 302 to the input of IC 306.

Change-over switch, S 302, is used to select whether the plus or the minus input of IC 306 is to be used. Thereby, the polarity of the output is determined. With increasing input voltage, the change in output voltage of IC 306 is either in positive or negative direction according to the position of the switch.

With voltage divider, R 332, P 304 and R 333, the voltage across Zener diodes, GI 304 and GI 305, is used as a reference voltage for switching through S 302 to the plus or minus input of IC 306.

The gain of IC 306 is adjusted with P 305. The control voltage is tapped-off the voltage divider, R 335-R 336, and connected to the output connector, Bu 302.

When using the control voltage output connector, the switch, S 304, is actuated. Thereby, the gain of the chopper amplifier is decreased by a factor of 10. And by

this procedure, the noise is held to a low value. Decoupling the control voltage output from the equipment chassis is done by R 326. Also see section 3.4.

7.3.4. Calibration level generator

The output of IC 307 is a constant voltage which is produced by a silicon reference element. This constant voltage output from IC 307 is placed across the voltage divider, R 361 to R 365. The gain of IC 307 is adjusted with P 306.

By means of S 303, the corresponding tap-off from the voltage divider is switched to the plus input of IC 308. Resistors, R 366, R 367 and R 368 supplement the internal resistance of the divider in such a way that it changes proportionally with the picked-off voltage. Thus the relative error caused by the input current of IC 308 remains constant in every position of the switch.

The output signal from IC 308 is fed through the buffer stage, T 310, and the resistor, R 372, to the calibration level output. By feeding back the output voltage to the minus input of IC 308, when $Z_{out} = 0$, the output voltage is held constant directly at the calibration level output, and when $Z_{out} = Z$, then the output voltage is held constant before resistor, R 372. Therefore, only the error of R 372 is included in the output impedance. By means of R 369, R 370 and P 307, there is an offset compensation for the IC 308.

7.3.5. Protective circuit

In order to protect the measuring thermo-couple from being overloaded with consequential destruction, the EPM-1 contains a protective circuit. A section of the protective circuit is within the Test Probe and for this reason, is included in the circuit diagram of the Test Probe TK-10.

When the thermo-couple is overloaded, the heating element emits light which causes a reaction on the base of the photo-transistor, T 1, which is of high sensitivity. T 1 conducts and cuts-off the following FET, T 2.

By way of T 303, the differential amplifier, T 304-T 305 is controlled. Thereby, in case of over load, T 304 conducts and T 305 is cut-off. The collector of T 305 now is at a positive operating voltage, and T 309 conducts, it is switched on. Indicator lamp, SL 301, is illuminated and indicates an overloaded condition. Simultaneously,

T 308 cuts-off and therewith switches the operating voltage off of Rel. 1. Thus, the measurement current circuit is opened.

When the protective circuit is energized, the positive going voltage on the collector of T 305, controls, in addition, the one shot multivibrator, T 306-T 307, which is held in a cut-off condition for 1 s by T 305. Only after this waiting time, can T_1-T_2 and T_3 issue a command to switch-over so that the measuring current circuit is again closed.

If the positive operating voltage disappears, then Rel 1 does not "open-circuit" when an overload occurs. In this case, the base of T 311 is put at emitter potential. The transistor cuts-off and switches off the operating voltage for the relay, Rel 1. And thus the measuring current circuit also is opened if the positive operating voltage disappears.

7.4. Power supply BN 564 (1)

The power supply consists of an a.c. power line filter, the voltage selector, the transformer, the rectifier and the voltage stabilizer.

7.4.1. Voltage stabilizer BN 427 (3)

The voltage stabilizer comprises a differential amplifier, a control circuit and a current limiter.

Differential amplifier, T 305-T 306 compares the actual value at the output between points 6 and 7 with the nominal value of Gl 302. Moreover, T 301 forms a high dynamic operating resistance for T 306 and amplifies the signal from T 305. From the differential amplifier and from T 301, the control circuit, T 302- T 303, is driven.

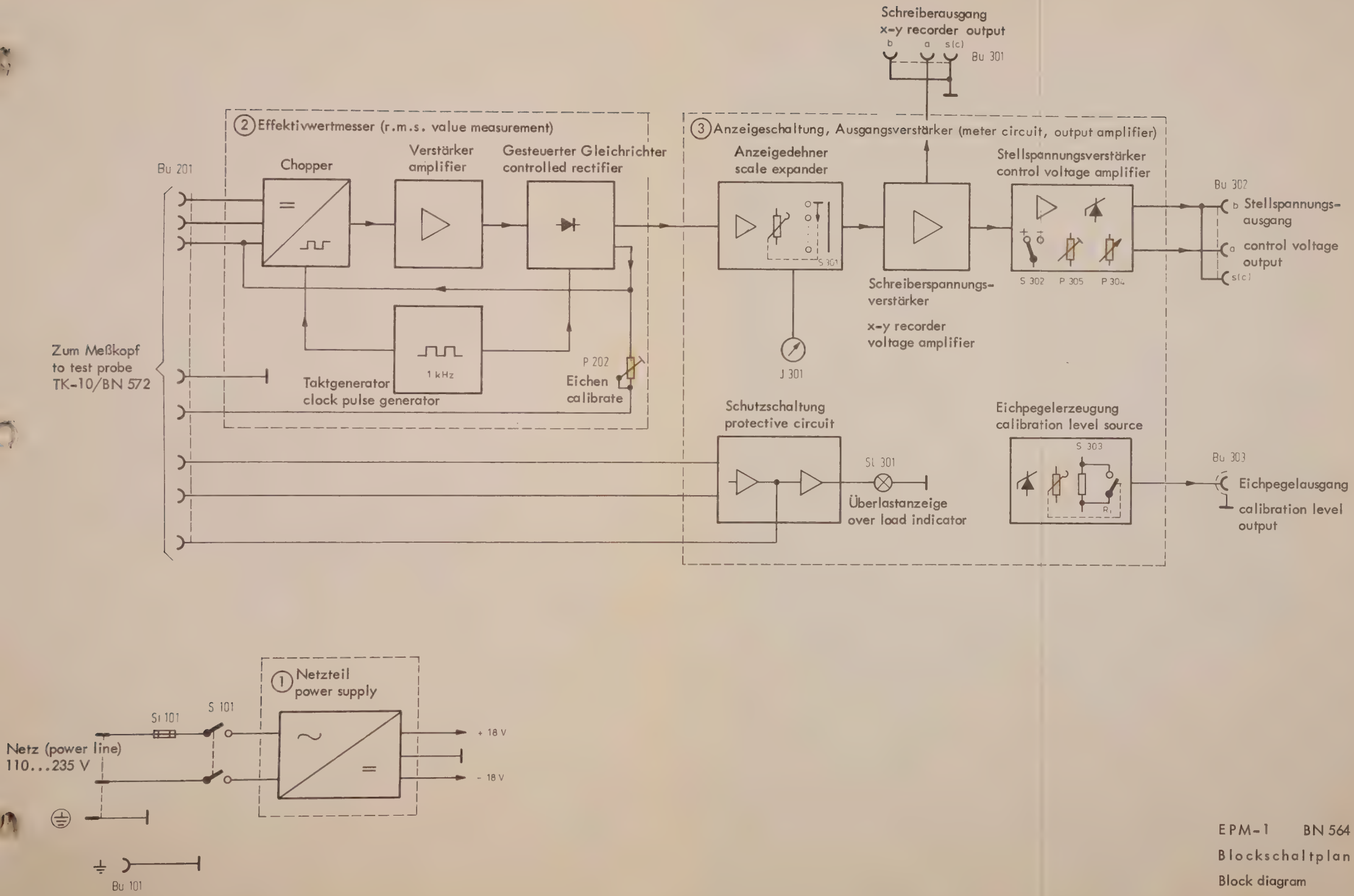
When the stabilizer is switched on, a base current flows through R 302 and this causes T 301 to conduct. Through T 305, the control circuit conducts thereby causing the output voltage of the stabilizer to build up. For a definite value of voltage, Gl 301 conducts, and the Zener current flows for Gl 302. Now R 302 has practically no more influence on the stabilization.

The current limiter, T 304, protects the control circuit against short circuits. T 304 is controlled by voltage drops across R 309 and R 307. Thereby, the voltage drop across

R 309 is dependent upon the output current, and the drop across R 307 depends upon the input voltage.

During normal operation, the sum of the voltage drops across R 307 and R 309 is smaller than the base-emitter voltage of T 304. Then, the transistor is cut-off. If the output current climbs without control, the voltage across T 309 climbs, and with it the control voltage for T 304. When the turn-on voltage of T 304 is achieved, T 304 takes over the base current from T 302. This causes the current in the control circuit to decrease. The output voltage breaks down, and now an auxiliary current flows from the divider R 304-R 308 and causes a positive voltage drop across R 307. This places a positive voltage at the base of T 304, and thus the output current when overloaded becomes smaller than the rated current.

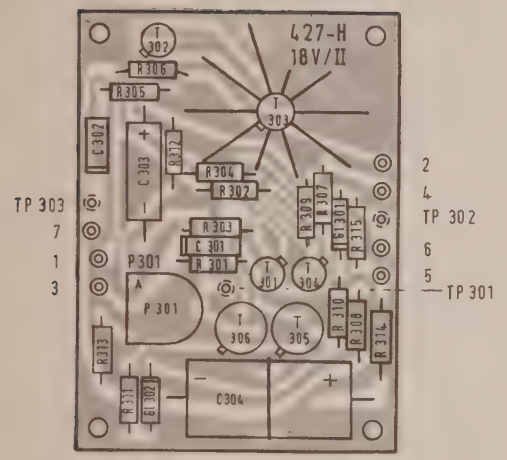
APPENDIX

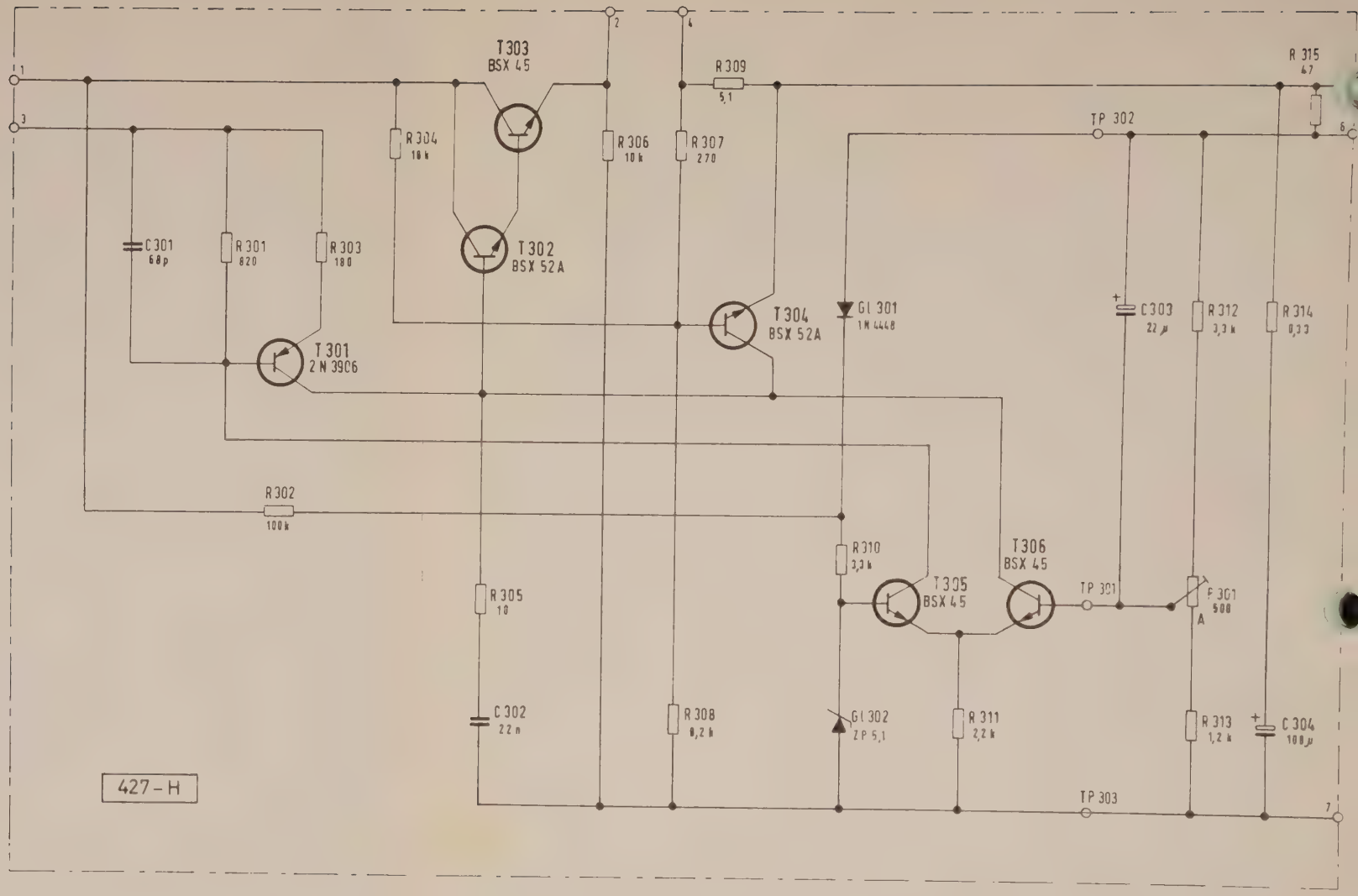


EPM-1 BN 564

Blockschaltplan

Block diagram



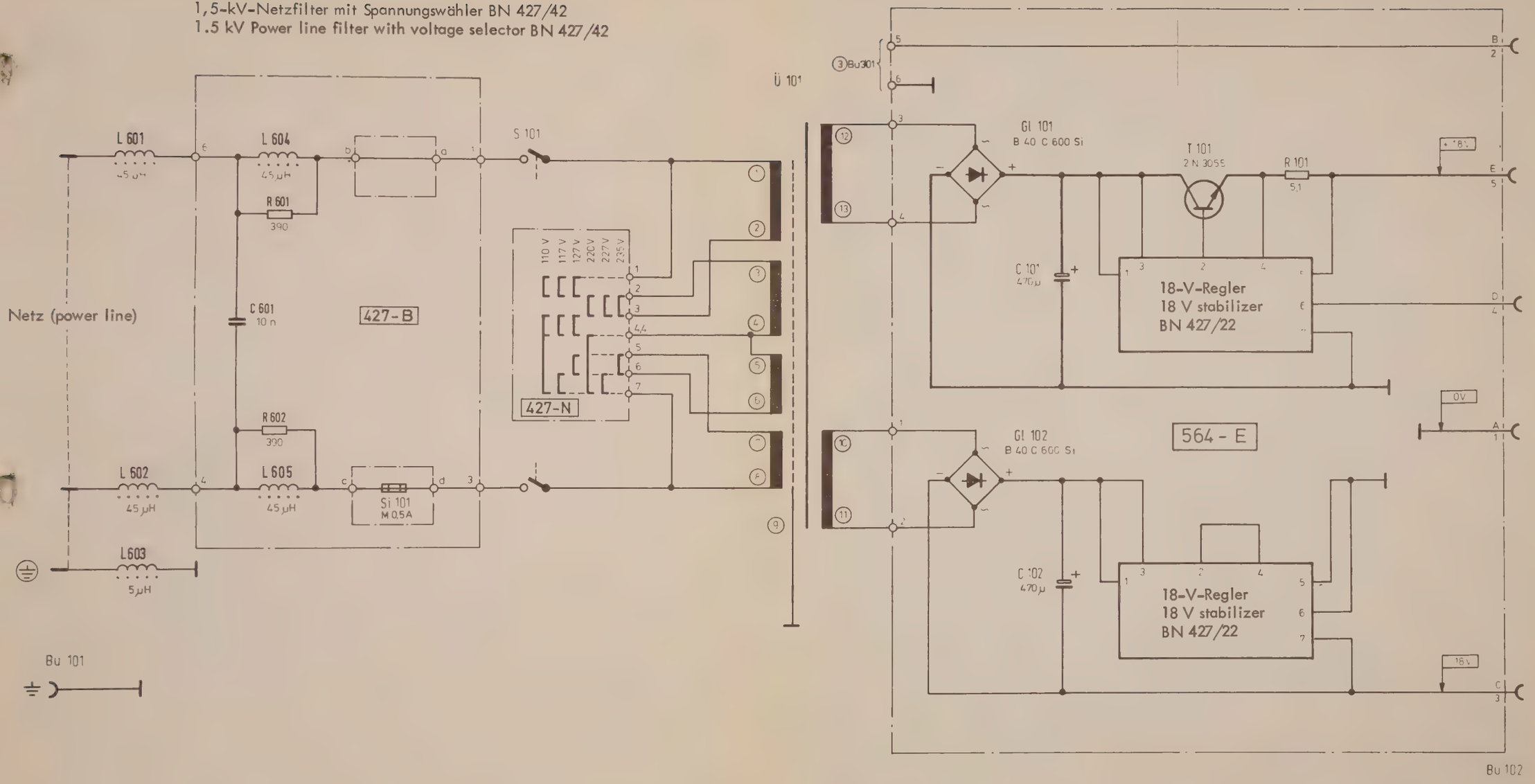


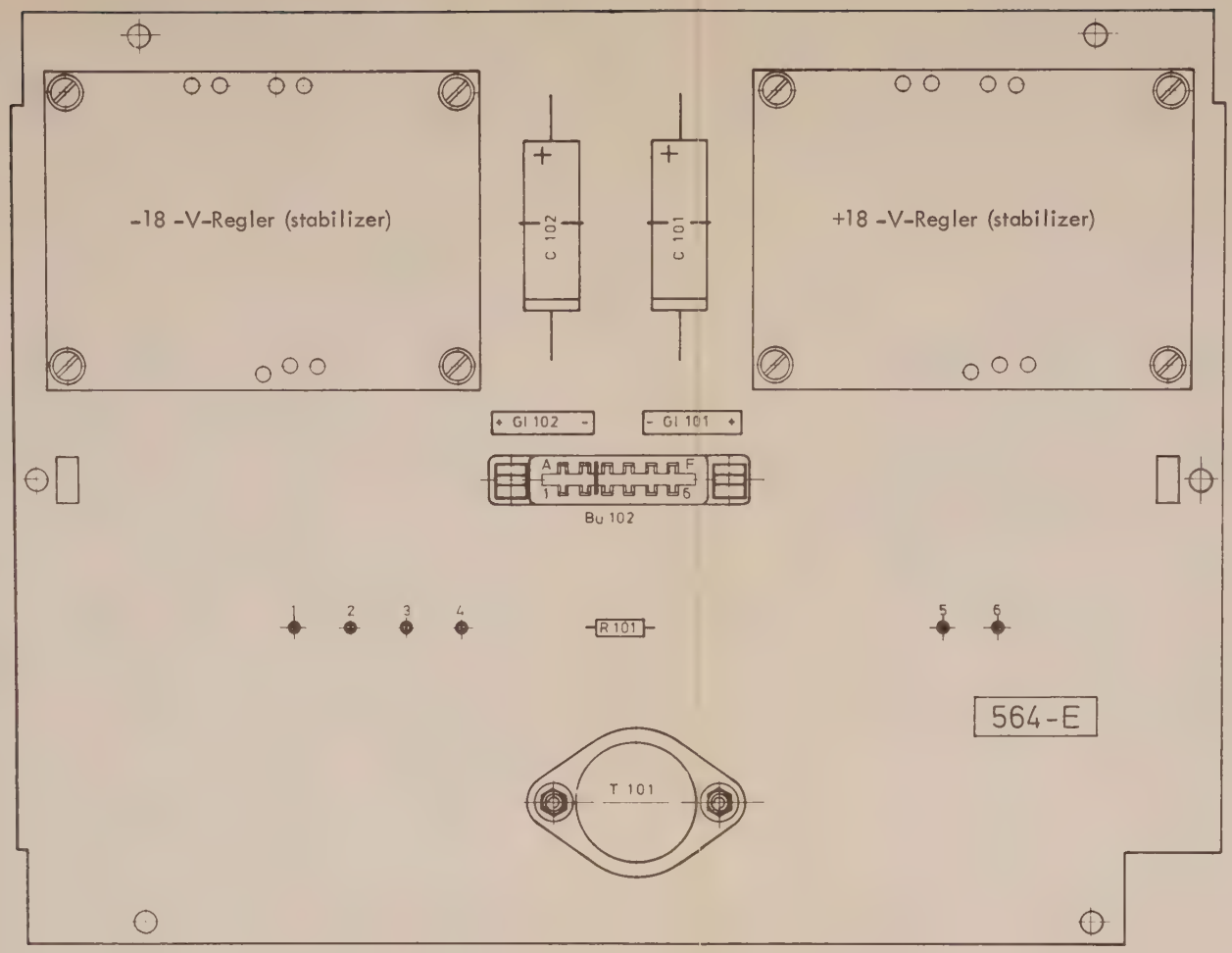
BN 427/22

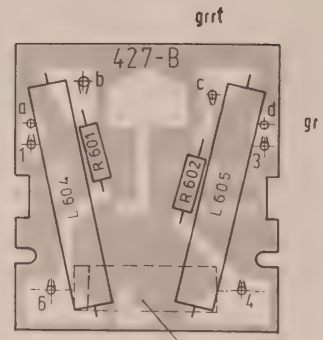
18-V-Regler

18 V stabilizer

1,5-kV-Netzfilter mit Spannungswähler BN 427/42
1.5 kV Power line filter with voltage selector BN 427/42







C 601 untenliegend

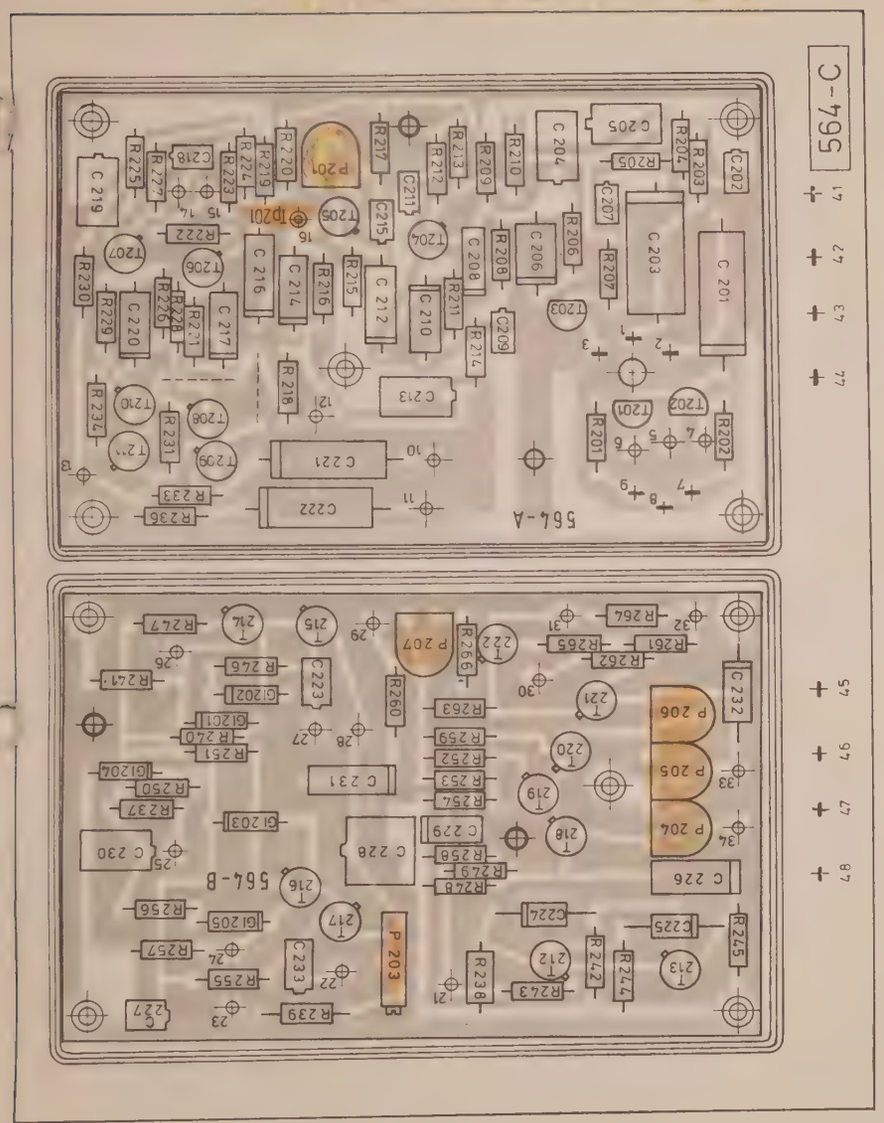
EPM-1 BN 564 (1)

Netzgrundkarte 564-E

Basic Card for Power Supply 564-E

1,5-kV-Netzfilter 427-B

1.5 kV Power Line Filter 427-B



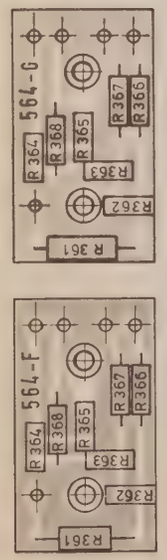
EPM-1 BN 564 (2)

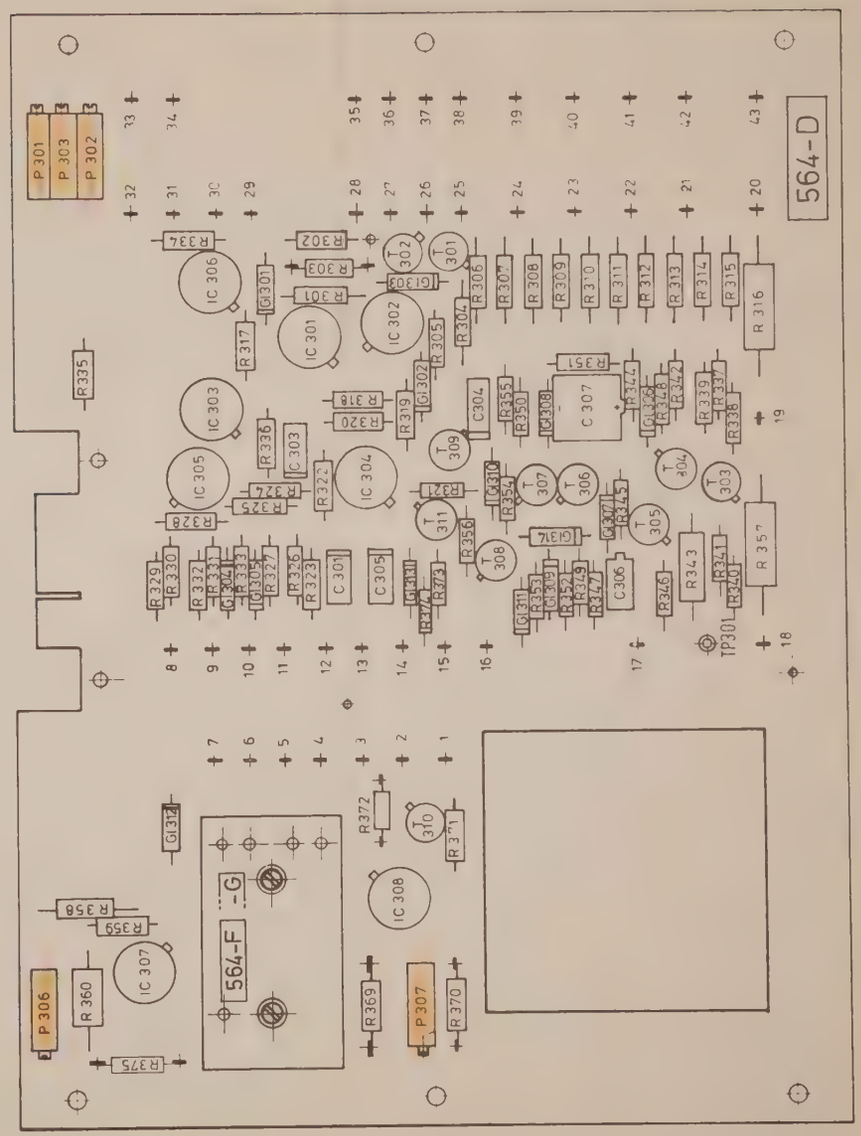
Trägerkarte 564-C

mit Taktgenerator, gesteuerter Gleichrichter 564-B und Chopperverstärker 564-A

Counting Card 564-C

with Clock Pulse Generator, Controlled rectifier 564-B and Chopper Amplifier 564-A





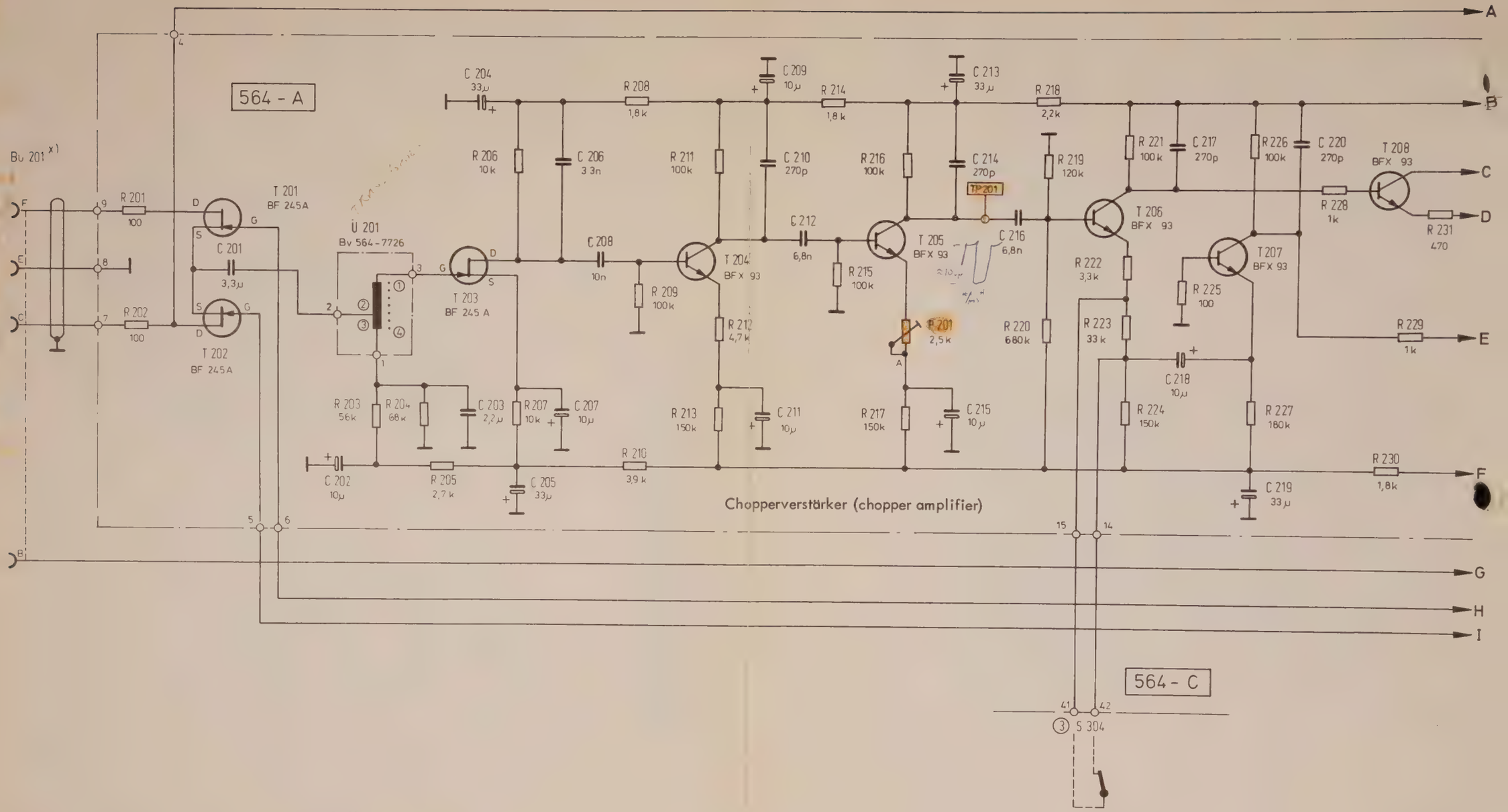
EPM-1 BN 564 (3)

Anzeigeschaltung, Ausgangsverstärker 564-D

75-Ω-Teiler 564-F, 50-Ω-Teiler 564-G

Meter Circuit, Output Amplifier 564-D

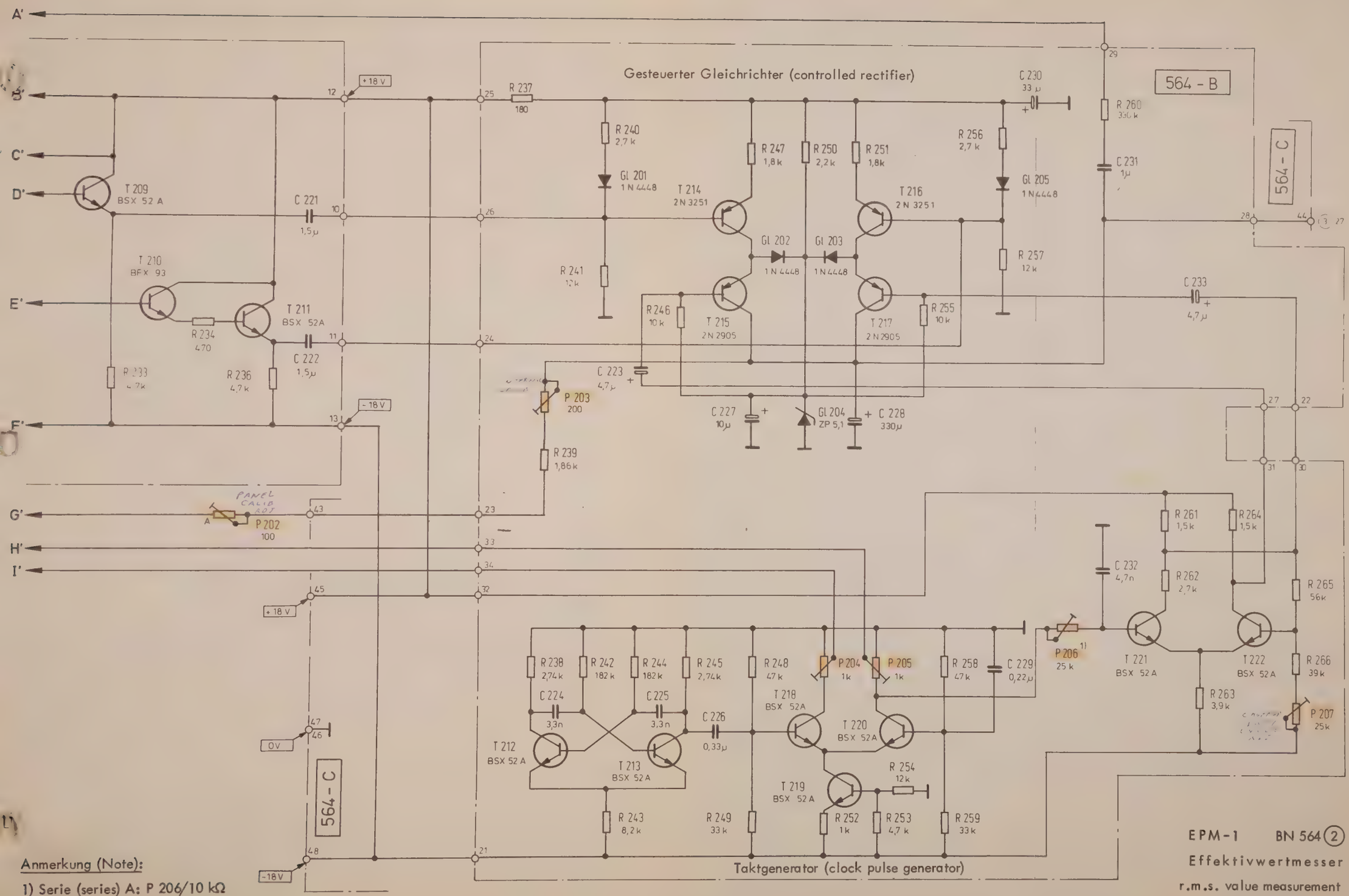
75 Ω Attenuator 564-F, 50 Ω Attenuator 564-G

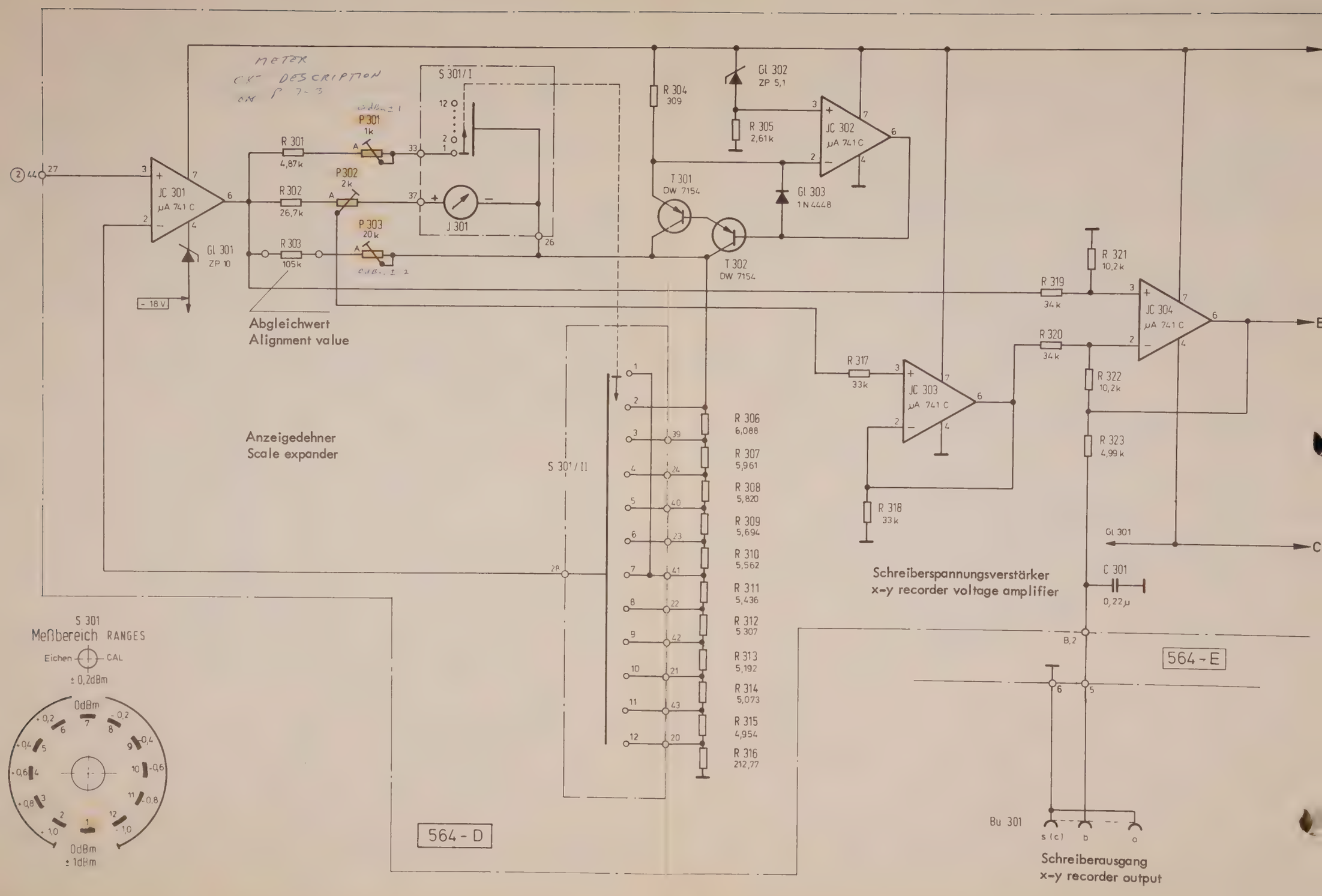


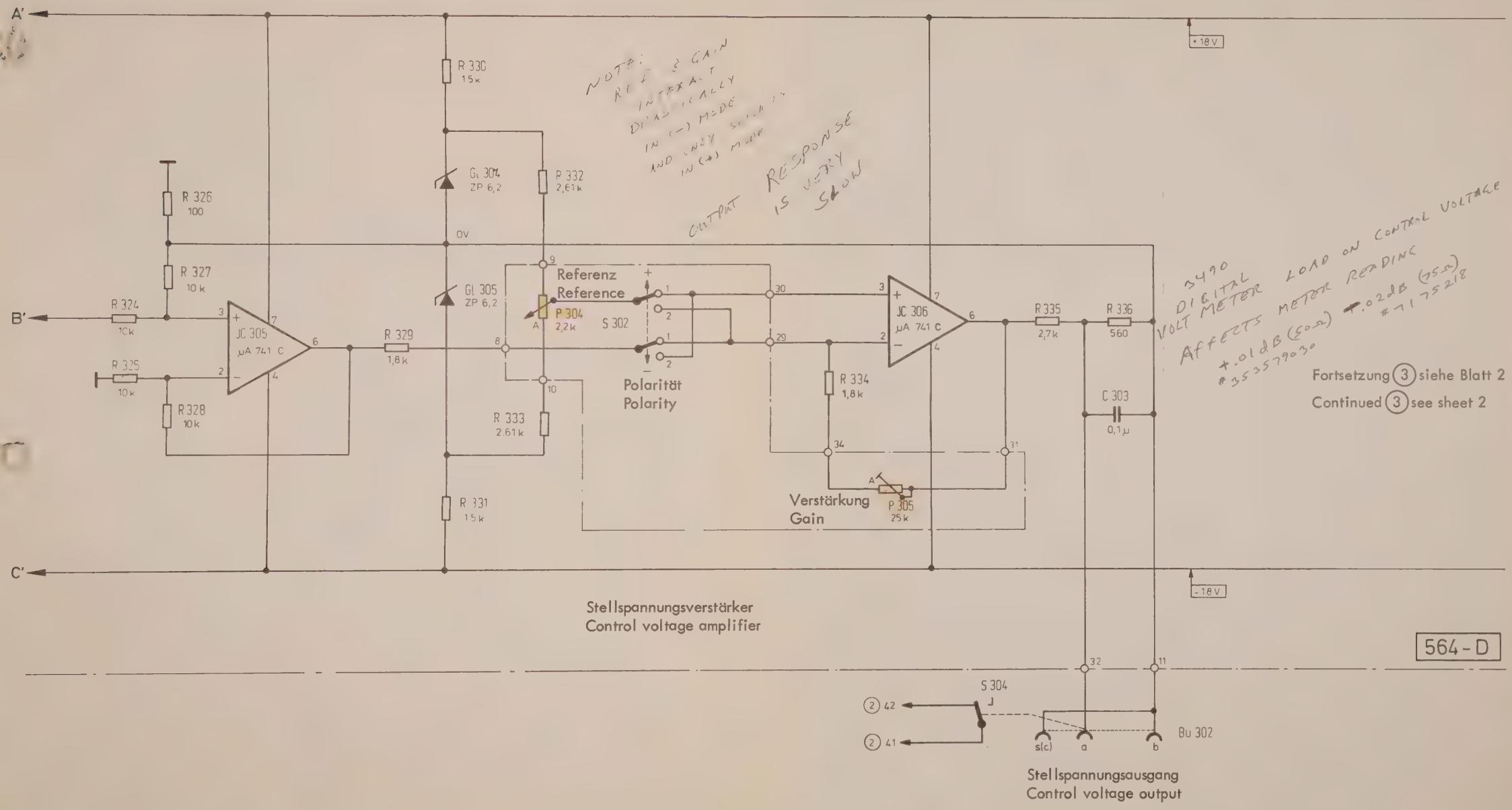
Bu 201

Auf Lötseite gesehen
seen from soldering terminals

x) Teil von Bu 201 siehe ③
portion of Bu 201 see ③


Gesteuerter Gleichrichter (controlled rectifier)
564 - B
564 - C
564 - C
T 209 BSX 52 A
T 210 BFX 93
T 211 BSX 52A
T 212 BSX 52 A
T 213 BSX 52 A
T 214 2N 3251
T 215 2N 2905
T 216 2N 3251
T 217 2N 2905
T 218 BSX 52A
T 219 BSX 52 A
T 220 BSX 52A
T 221 BSX 52 A
T 222 BSX 52 A
R 237 180
R 240 2,7 k
R 241 12k
R 246 10 k
R 247 1,8k
R 250 2,2k
R 251 1,8k
R 255 10k
R 256 2,7 k
R 257 12k
R 260 330 k
R 233 4,7k
R 234 470
R 236 4,7 k
R 238 2,74k
R 242 182 k
R 244 182k
R 245 2,74k
R 248 47 k
R 254 12k
R 258 47k
R 259 33k
R 261 1,5k
R 262 2,7k
R 263 3,9k
R 264 1,5k
R 265 56k
R 266 39k
R 243 8,2 k
R 249 33 k
R 252 1k
R 253 4,7 k
C 221 1,5µ
C 222 1,5µ
C 223 4,7µ
C 224 3,3n
C 225 3,3n
C 226 0,33µ
C 227 10µ
C 228 330µ
C 229 0,22µ
C 230 33 µ
C 231 1µ
C 232 4,7n
C 233 4,7µ
Gl 201 1 N 4448
Gl 202 1 N 4448
Gl 203 1 N 4448
Gl 204 ZP 5,1
Gl 205 1 N 4448
P 202 100
P 203 200
P 204 1k
P 205 1k
P 206 25 k
P 207 25k
PANEL CALIB ADJ
+ 18 V
- 18 V
0V
Taktgenerator (clock pulse generator)
A'
B'
C'
D'
E'
F'
G'
H'
I'
L'
EPM-1 BN 564 (2)
Effektivwertmesser
r.m.s. value measurement
Anmerkung (Note):
1) Serie (series) A: P 206/10 kΩ


METER
CKT DESCRIPTION
ON P 7-3
S 301/I
P 301
1k
R 301
4,87k
P 302
2k
R 302
26,7k
P 303
20k
R 303
105k
JC 301
µA 741 C
Gl 301
ZP 10
- 18 V
J 301
R 304
309
Gl 302
ZP 5,1
R 305
2,61k
JC 302
µA 741 C
T 301
DW 7154
Gl 303
1 N 4448
T 302
DW 7154
Abgleichwert
Alignment value
Anzeigedehner
Scale expander
S 301/II
R 306
6,088
R 307
5,961
R 308
5,820
R 309
5,694
R 310
5,562
R 311
5,436
R 312
5 307
R 313
5,192
R 314
5,073
R 315
4,954
R 316
212,77
R 317
33k
JC 303
µA 741 C
R 318
33k
R 319
34k
R 320
34k
R 321
10,2k
JC 304
µA 741 C
R 322
10,2k
R 323
4,99k
Gl 301
C 301
0,22µ
Schreiberspannungsverstärker
x-y recorder voltage amplifier
564 - D
564 - E
Bu 301
Schreiberausgang
x-y recorder output
S 301
Meßbereich RANGES
Eichen CAL
± 0,2dBm
0dBm
± 1dBm

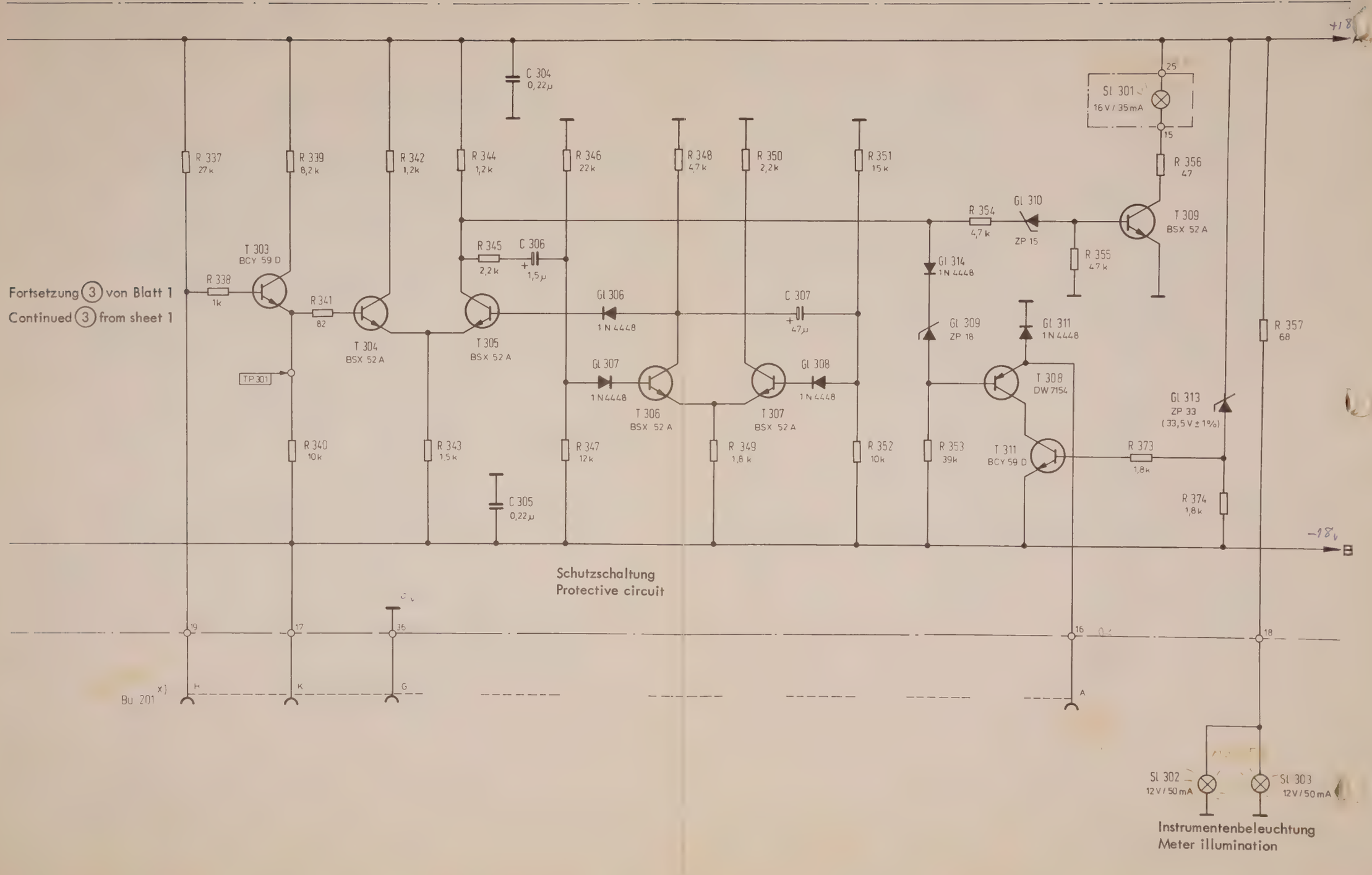


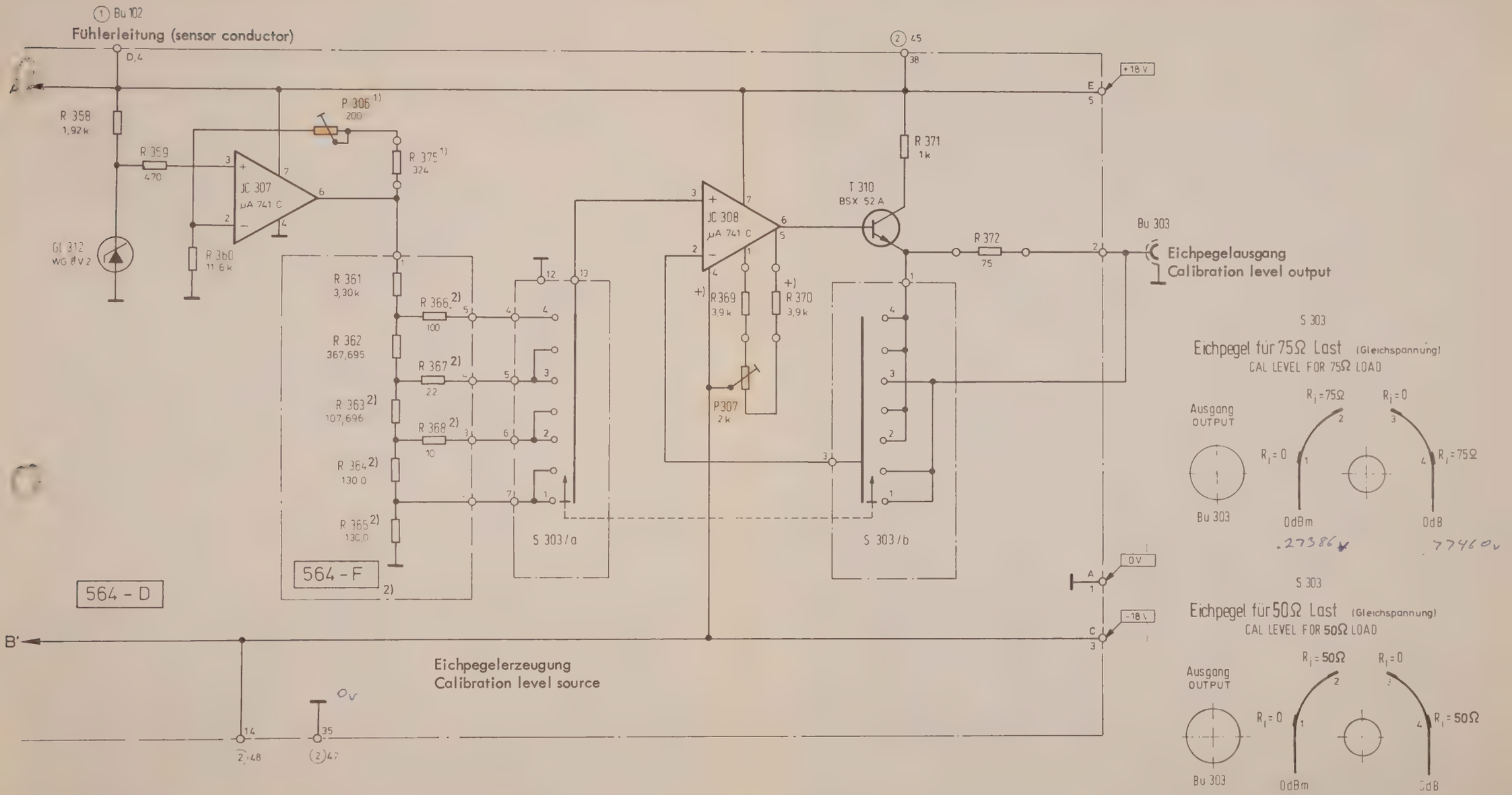
EPM-1 BN 564 (3)

Anzeigeschaltung, Ausgangsverstärker

Meter Circuit, Output Amplifier

Blatt (Sheet) 1


+18
-18
B
C 304
0,22µ
R 337
27k
R 339
8,2k
R 342
1,2k
R 344
1,2k
R 346
22k
R 348
4,7k
R 350
2,2k
R 351
15k
25
Sl 301
16V/35mA
15
R 356
47
R 354
4,7k
Gl 310
ZP 15
T 309
BSX 52A
R 355
4,7k
Gl 314
1N4448
R 345
2,2k
C 306
1,5µ
T 303
BCY 59 D
R 338
1k
R 341
82
T 304
BSX 52A
T 305
BSX 52A
Gl 306
1N4448
C 307
47µ
Gl 309
ZP 18
Gl 311
1N4448
R 357
68
Fortsetzung (3) von Blatt 1
Continued (3) from sheet 1
TP 301
Gl 307
1N4448
T 306
BSX 52A
T 307
BSX 52A
Gl 308
1N4448
T 308
DW 7154
Gl 313
ZP 33
(33,5V±1%)
R 340
10k
R 343
1,5k
R 347
12k
R 349
1,8k
R 352
10k
R 353
39k
T 311
BCY 59 D
R 373
1,8k
R 374
1,8k
C 305
0,22µ
Schutzschaltung
Protective circuit
19
17
36
16
18
H
K
G
A
Bu 201 x)
Sl 302
12V/50mA
Sl 303
12V/50mA
Instrumentenbeleuchtung
Meter illumination



S 303

Eichpegel für 75Ω Last (Gleichspannung)

CAL LEVEL FOR 75Ω LOAD

S 303

Eichpegel für 50Ω Last (Gleichspannung)

CAL LEVEL FOR 50Ω LOAD

Anmerkungen (Notes):

1) Serie (series) A: P 306/1 kΩ, R 375 entfällt (deleted)

2) Ausführung (version) 50 Ω/BN 564/1: 564-G,
R 363/155,406 Ω; R 364/106,145 Ω; R 365/106,145 Ω;
R 366/120 Ω; R 367/27 Ω; R 368/6,8 Ω

x) Bu 201 siehe (see) ②

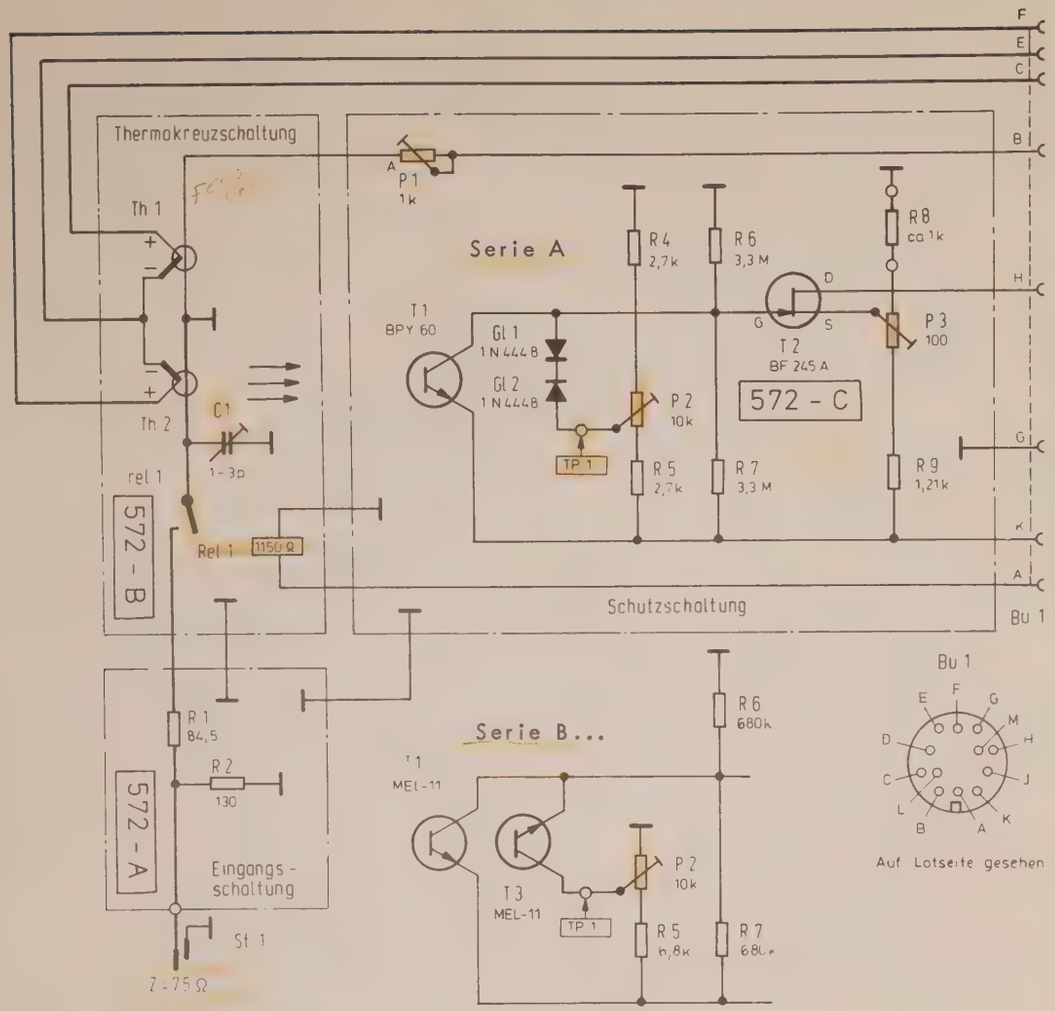
+) R 369, R 370 Abgleichwerte (alignment values)

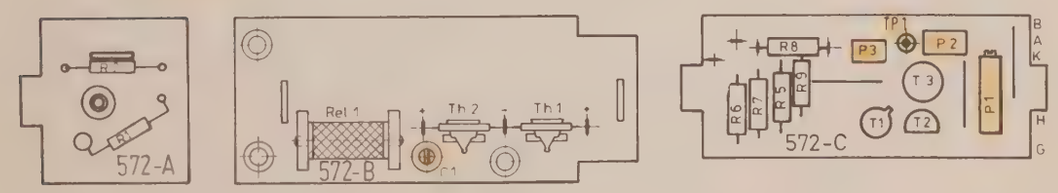
EPM-1 BN 564/0, 564/1 ③

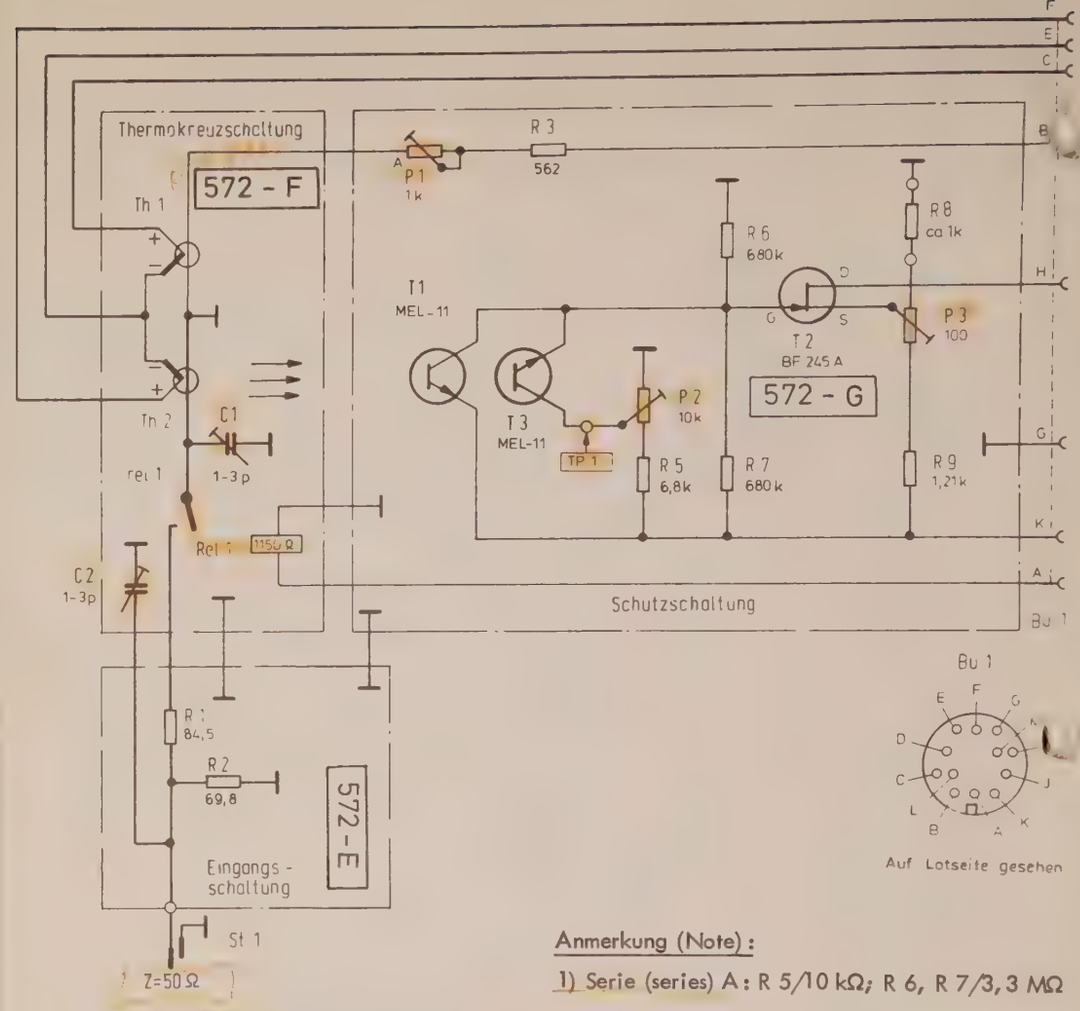
Anzeigeschaltung, Ausgangsverstärker

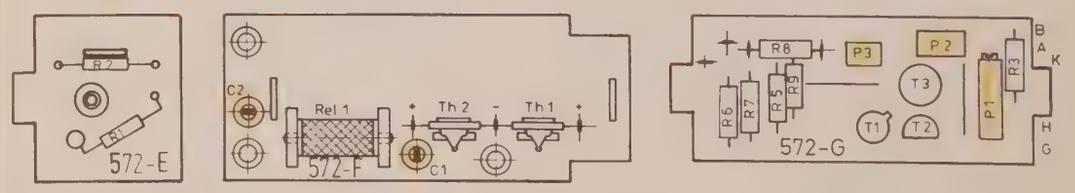
Meter Circuit, Output Amplifier

Blatt (Sheet) 2









Anmerkung (Note):

1) Serie (series) A: R 5/10 kΩ; R 6, R 7/3,3 MΩ

Vokabular (Vocabulary):

Auf Lötseite gesehen	seen from soldering terminals
Eingangsschaltung	input circuit
Schutzschaltung	protective circuit
Thermokreuzschaltung	thermocouple circuit

TK-10 BN 572/0
Meßkopf 75 Ω
Test Probe 75 Ω

TK-10 BN 5[illegible]
Meßkopf 50 Ω
Test Probe 50 Ω

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
R 301	1	Schichtwiderstand	820 Ω / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 302	1	Schichtwiderstand	100 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 303	1	Schichtwiderstand	180 Ω / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 304	1	Schichtwiderstand	18 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 305	1	Schichtwiderstand	10 Ω / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R [illegible]	1	Schichtwiderstand	10 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R [illegible]07	1	Schichtwiderstand	270 Ω / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 308	1	Schichtwiderstand	8,2 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 309	1	Schichtwiderstand	5,1 Ω / 5% / K12	L C A 0309	M i G
R 310	1	Schichtwiderstand	3,3 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 311	1	Schichtwiderstand	2,2 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 312	1	Schichtwiderstand	3,3 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 313	1	Schichtwiderstand	1,2 kΩ / 5% / K1 2 / 0309	WN 18 / 3 / 1	
R 314	1	Schichtwiderstand	0,33 Ω / 10 % / 1 W	Km 3	Resista
R 315	1	Schichtwiderstand	47 Ω / 5% / K1 2 / 0309	WN 18 / 3 / 1	

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
C 301	1	Ker.- Kond.	68 pF / 2% / N 150	WN 110 / 2 / 3	
C 302	1	Kf. - Kond.	22 nF / 20% / 400 V	WN 110 / 3 / 7	
C 303	1	Elko	22 µF / + 50 - 10% / 16 V	WN 110 / 5 / 40	
C 304	1	Elko	100 µF / +50 - 10% / 40 V	WN 110 / 5 / 40	
Gl 301	1	Diode		1 N 4448	Cosse
Gl 302	1	Diode	ZP 5,1 rot	WN 140 / 3 / 1	
P 301	1	Schichtdrehwiderst.	500 Ω / lin. / 1 W	WN 17 / 2 / 6	
T 301	1	Transistor		2 N 3906	S G S
T 302	1	Transistor		BSX 52 A	Ditrathera
T 303	1	Transistor	Stromverstärkungsgruppe 16	BSX 45	
T 304	1	Transistor		BSX 52 A	Ditrathera
T 305	1	Transistor	Stromverstärkungsgruppe 16	BSX 45	
T 306	1	Transistor	Stromverstärkungsgruppe 16	BSX 45	

BN 427/22
18-V-Regler (18 V stabilizer)

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
R 601	1	Schichtwiderst.	390 Ω / 5 % / K1 2 / 0309	WN 18 / 3 / 1	
R 602	1	Schichtwiderst.	390 Ω / 5 % / K1 2 / 0309	WN 18 / 3 / 1	
St 601	1	Gerätestecker		WN 119 / 3 / 5	
C [illegible]	1	Papierkondensator	10 nF / 20 % / 1000 V	WN 110 / 1 / 1	

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
L 601	1	Spule	45 µH / 1,5 A	B 82501 - C - C 12	Siemens
L 602	1	Spule	45 µH / 1,5 A	B 82501 - C - C 12	Siemens
L 603	1	Spule	5 µH / 10 A	B 82501 - B - C 21	Siemens
L 604	1	Spule	45 µH / 1,5 A	B 82501 - C - C 12	Siemens
L 605	1	Spule	45 µH / 1,5 A	B 82501 - C - C 12	Siemens
	1	Spannungswähler	S 501 siehe Bv. 427 - 7605.41		

BN 427/42
1,5-kV-Netzfilter mit Spannungswähler (1.5 kV power line filter with voltage selector)

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
R 101	1	Schichtwid.	5,1 Ω / 5% / K1 2 / 0309	0000 7133 79	
C 101	1	Elko	470 µF / + 50 - 10 % / 40 V	0000 7162 07	WN 110 / 5 / 40
C 102	1	Elko	470 µF / + 50 - 10 % / 40 V	0000 7162 07	WN 110 / 5 / 40
Gl 101	1	Gleichrichter	B 40 C 600 S1	0000 7129 40	
Gl 102	1	Gleichrichter	B 40 C 600 S1	0000 7129 40	
T 101	1	Transistor	2 N 3055	0000 7123 26	

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
Si 101	1	G - Schmelzeinsatz	M 0,5 C	0000 7110 37	WN 115 / 2 / 1
S 101	1	Schalter		00 - 1800.38 / 5	
Tr 101	1	Netztrafo		Bv. 564 - 7701	
Bu 101	1	Buchse		0000 7110 94	1 WN 119 / 2 / 5
Bu 102	1	Buchse	A 2 x 6	0000 7139 82	WN 119 / 5 / 7
	2	18 V - Regler		BN 427 / 22	
	1	Netzfilter - 1,5 kV m. Spannungsw.		BN 427 / 42	

EPM-1 BN 564 (1)
Netzteil (power supply)

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 201	1	Schichtwid.	100 Ω / 5% / K1 2 / 0309	0000 7100 13	
R 202	1	Schichtwid.	100 Ω / 5% / K1 2 / 0309	0000 7100 13	
R 203	1	Schichtwid.	56 kΩ / 5% / K1 2 / 0309	0000 7100 46	
R 204	1	Schichtwid.	68 kΩ / 5% / K1 2 / 0309	0000 7100 47	
R 205	1	Schichtwid.	2,7 kΩ / 5% / K1 2 / 0309	0000 7100 30	
R 206	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 207	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 208	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 209	1	Schichtwid.	100 kΩ / 5% / K1 2 / 0309	0000 7100 49	
R 210	1	Schichtwid.	3,9 kΩ / 5% / K1 2 / 0309	0000 7100 32	
R 211	1	Schichtwid.	100 kΩ / 5% / K1 2 / 0309	0000 7100 49	
R 212	1	Schichtwid.	4,7 kΩ / 5% / K1 2 / 0309	0000 7100 33	
R 213	1	Schichtwid.	150 kΩ / 5% / K1 2 / 0309	0000 7100 51	
R 214	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 215	1	Schichtwid.	100 kΩ / 5% / K1 2 / 0309	0000 7100 49	
R 216	1	Schichtwid	100 kΩ / 5% / K1 2 / 0309	0000 7100 49	
R 217	1	Schichtwid.	150 kΩ / 5% / K1 2 / 0309	0000 7100 51	
R 218	1	Schichtwid.	2,2 kΩ / 5% / K1 2 / 0309	0000 7100 29	
R 219	1	Schichtwid.	120 kΩ / 5% / K1 2 / 0309	0000 7100 50	
R 220	1	Schichtwid.	680 kΩ / 5% / K1 2 / 0309	0000 7100 59	
R 221	1	Schichtwid.	100 kΩ / 5% / K1 2 / 0309	0000 7100 49	
R 222	1	Schichtwid.	3,3 kΩ / 5% / K1 2 / 0309	0000 7100 31	
R 223	1	Schichtwid.	33 kΩ / 5% / K1 2 / 0309	0000 7100 43	
R 224	1	Schichtwid.	150 kΩ / 5% / K1 2 / 0309	0000 7100 51	
R 225	1	Schichtwid.	100 Ω / 5% / K1 2 / 0309	0000 7100 13	
R 226	1	Schichtwid.	100 kΩ / 5% / K1 2 / 0309	0000 7100 49	
R 227	1	Schichtwid.	180 kΩ / 5% / K1 2 / 0309	0000 7100 52	
R 228	1	Schichtwid.	1 kΩ / 5% / K1 2 / 0309	0000 7100 25	
R 229	1	Schichtwid.	1 kΩ / 5% / K1 2 / 0309	0000 7100 25	
R 230	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 231	1	Schichtwid.	470 Ω / 5% / K1 2 / 0309	0000 7100 21	
R 233	1	Schichtwid.	4,7 kΩ / 5% / K1 2 / 0309	0000 7100 33	
R 234	1	Schichtwid.	470 Ω / 5% / K1 2 / 309	0000 7100 21	
R 236	1	Schichtwid.	4,7 kΩ / 5% / K1 2 / 0309	0000 7100 33	
R 237	1	Schichtwid.	180 Ω / 5% / K1 2 / 0309	0000 7100 16	
R 238	1	Schichtwid.	2,74 kΩ/ 1% / K1 0,5 / 0309	0000 7166 06	
R 239	1	Schichtwid	1,86 kΩ/ 1% / 75 mW / Tk 50	0000 7219 38	WLAD
R 240	1	Schichtwid.	2,7 kΩ / 5% / K1 2 / 0309	0000 7100 30	
R 241	1	Schichtwid.	12 kΩ / 5% / K1 2 / 0309	0000 7100 38	
R 242	1	Schichtwid.	182 kΩ / 1% / K1 0,5 / 0309	0000 7167 69	
R 243	1	Schichtwid.	8,2 kΩ / 5% / K1 2 / 0309	0000 7100 36	
R 244	1	Schichtwid.	182 kΩ / 1% / K1 0,5 / 0309	0000 7167 69	
R 245	1	Schichtwid.	2,74 kΩ / 1% / K1 0,5 / 0309	0000 7166 06	
R 246	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 247	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 248	1	Schichtwid	47 kΩ / 5% / K1 2 / 0309	0000 7100 45	
R 249	1	Schichtwid.	33 kΩ / 5% / K1 2 / 0309	0000 7100 43	
R 250	1	Schichtwid.	2,2 kΩ / 5% / K1 2 / 0309	0000 7100 29	

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 251	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 252	1	Schichtwid.	1 kΩ / 5% / K1 2 / 0309	0000 7100 25	
R 253	1	Schichtwid.	4,7 kΩ / 5% / K1 2 / 0309	0000 7100 33	
R 254	1	Schichtwid.	12 kΩ / 5% / K1 2 / 0309	0000 7100 38	
R 255	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 256	1	Schichtwid.	2,7 kΩ / 5% / K1 2 / 0309	0000 7100 30	
R 257	1	Schichtwid.	12 kΩ / 5% / K1 2 / 0309	0000 7100 38	
R 258	1	Schichtwid.	47 kΩ / 5% / K1 2 / 0309	0000 7100 45	
R 259	1	Schichtwid.	33 kΩ / 5% / K1 2 / 0309	0000 7100 43	
R 260	1	Schichtwid.	330 kΩ / 5% / K1 2 / 0309	0000 7100 55	
R 261	1	Schichtwid.	1,5 kΩ / 5% / K1 2 / 0309	0000 7100 27	
R 262	1	Schichtwid.	2,7 kΩ / 5% / K1 2 / 0309	0000 7100 30	
R 263	1	Schichtwid.	3,9 kΩ / 5% / K1 2 / 0309	0000 7100 32	
R 264	1	Schichtwid.	1,5 kΩ / 5% / K1 2 / 0309	0000 7100 27	
R 265	1	Schichtwid.	56 kΩ / 5% / K1 2 / 0309	0000 7100 46	
R 266	1	Schichtwid.	39 kΩ / 5% / K1 2 / 0309	0000 7100 44	
P 201	1	Schichtdrehwid.	2,5 kΩ / lin. / 0,5 W	0000 7129 75	1 WN 17 / 2 / B
P 202	1	Schichtdrehwid.	100 Ω / lin. / 0,3 W	0000 7219 31	55 U dest.Nr.600 Buchse:M 10x0,75 8mm lang Achse:4 mm Φ 16 mm lang
P 203	1	Spindelwid.	200 Ω	0000 7197 40	WN 17 / 4 / 4
P 204	1	Schichtdrehwid	1 kΩ / lin. 0,5 W	0000 7104 42	1 WN 17 / 2 / B
P 205	1	Schichtdrehwid.	1 kΩ / lin. / 0,5 W	0000 7104 42	1 WN 17 / 2 / B
P 206	1	Schichtdrehwid.	25 kΩ / lin. / 0,5 W	0000 7104 48	1 WN 17 / 2 / B 1)
P 207	1	Schichtdrehwid.	25 kΩ / lin. / 0,5 W	0000 7104 48	1 WN 17 / 2 / B
C 201	1	Kf. - Kond.	3,3 µF / 20 % / 63 V	0000 7141 88	B 32 110 - E 9330
C 202	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61
C 203	1	Kf. - Kond.	2,2 µF / 20 % / 63 V	0000 7147 34	B 32110 - E 9225 - M
C 204	1	Elko	33 µF / 20 % / 25 V	0000 7206 65	WN 110 / 5 / 61
C 205	1	Elko	33 µF / 20 % / 25 V	0000 7206 65	WN 110 / 5 / 61
C 206	1	Kf. - Kond	3,3 nF / 2 % / 160 V	0000 7107 30	WN 110 / 3 / 1
C 207	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61
C 208	1	Kf. - Kond.	10 nF / 20 % / 630 V	0000 7156 90	WN 110 / 3 / 7
C 209	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61
C 210	1	Kf. - Kond.	270 pF / 2 % / 160 V	0000 7107 20	WN 110 / 3 / 1
C 211	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61
C 212	1	Kf. - Kond.	6,8 nF / 10 % / 160 V	0000 7161 98	WN 110 / 3 / 2
C 213	1	Elko	33 µF / 20 % / 25 V	0000 7206 65	WN 110 / 5 / 61
C 214	1	Kf. - Kond.	270 pF / 2 % / 160 V	0000 7107 20	WN 110 / 3 / 1
C 215	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61
C 216	1	Kf. - Kond.	6,8 nF / 10 % / 160 V	0000 7161 98	WN 110 / 3 / 2
C 217	1	Kf. - Kond.	270 pF / 2 % / 160 V	0000 7107 20	WN 110 / 3 / 1
C 218	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61

Serie A: 1) 10 kΩ

Fortsetzung (continued)

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
C 219	1	Elko	33 µF / 20 % / 25 V	0000 7206 65	WN 110 / 5 / 61
C 220	1	Kf. - Kond.	270 pF / 2 % / 160 V	0000 7107 20	WN 110 / 3 / 1
C 221	1	Kf. - Kond.	1,5 µF / 20 % / 63 V	0000 7147 33	B 32110 - E 9155 - M
C 222	1	Kf. - Kond.	1,5 µF / 20 % / 63 V	0000 7147 33	B 32110 - E 9155 - M
C 223	1	Elko	4,7 µF / 20 % / 35 V	0000 7109 82	WN 110 / 5 / 61
C 224	1	Kf. - Kond.	3,3 nF / 2 % / 160 V	0000 7107 30	WN 110 / 3 / 1
C 225	1	Kf. - Kond.	3,3 nF / 2 % / 160 V	0000 7107 30	WN 110 / 3 / 1
C 226	1	Kf. - Kond.	0,33 µF / 20 % / 100 V	0000 7150 12	WN 110 / 3 / 7
C 227	1	Elko	10 µF / 20 % / 25 V	0000 7158 30	WN 110 / 5 / 61
C 228	1	Elko	330 µF / 20 % / 6,3 V	0000 7109 56	WN 110 / 5 / 61
C 229	1	Kf. - Kond.	0,22 µF / 20 % / 100 V	0000 7107 42	WN 110 / 3 / 7
C 230	1	Elko	33 µF / 20 % / 25 V	0000 7206 65	WN 110 / 5 / 61
C 231	1	Kf. - Kond.	1 µF / 20 % / 100 V	0000 7129 08	WN 110 / 3 / 7
C 232	1	Kf. - Kond.	4,7 nF / 10 % / 160 V	0000 7206 75	WN 110 / 3 / 2
C 233	1	Elko	4,7 µF / 20 % / 35 V	0000 7109 82	WN 110 / 5 / 61
Bu 201	1	Buchse	B 12	0000 7111 61	WN 119 / 7 / 3
Ü 201	1	Übertrager		Bv. 564 - 7726	
G1 201	1	Diode	1 N 4448	0000 7122 76	
G1 202	1	Diode	1 N 4448	0000 7122 76	
G1 203	1	Diode	1 N 4448	0000 7122 76	
G1 204	1	Z - Diode	ZP 5,1	0000 7126 30	
G1 205	1	Diode	1 N 4448	0000 7122 76	

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
T 201	1	Transistor	BF 245 A	0000 7120 50	
T 202	1	Transistor	BF 245 A	0000 7120 50	
T 203	1	Transistor	BF 245 A	0000 7120 50	
T 204	1	Transistor	BFX 93	0000 7183 26	
T 205	1	Transistor	BFX 93	0000 7183 26	
T 206	1	Transistor	BFX 93	0000 7183 26	
T 207	1	Transistor	BFX 93	0000 7183 26	
T 208	1	Transistor	BFX 93	0000 7183 26	
T 209	1	Transistor	BSX 52 A	0000 7121 23	
T 210	1	Transistor	BFX 93	0000 7183 26	
T 211	1	Transistor	BSX 52 A	0000 7121 23	
T 212	1	Transistor	BSX 52 A	0000 7121 23	
T 213	1	Transistor	BSX 52 A	0000 7121 23	
T 214	1	Transistor	2 N 3251	0000 7123 35	
T 215	1	Transistor	2 N 2905	0000 7123 17	
T 216	1	Transistor	2 N 3251	0000 7123 35	
T 217	1	Transistor	2 N 2905	0000 7123 17	
T 218	1	Transistor	BSX 52 A	0000 7121 23	
T 219	1	Transistor	BSX 52 A	0000 7121 23	
T 220	1	Transistor	BSX 52 A	0000 7121 23	
T 221	1	Transistor	BSX 52 A	0000 7121 23	
T 222	1	Transistor	BSX 52 A	0000 7121 23	

EPM-1 BN 564 (2)
Effektivwertmesser (r.m.s. value measurement)

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 301	1	Schichtwid.	4,87 kΩ / 1% / 75 mW / Tk 50	0000 7212 13	MLAD
R 302	1	Schichtwid.	26,7 kΩ / 1% / 75 mW / Tk 50	0000 7212 14	MLAD
R 303	1	Schichtwid.	105 kΩ / 1% / K1 0,5 / 0309	0000 7167 47	Abgleichwert
R 304	1	Schichtwid.	309 Ω/ 1% / Tk 50 / SRA 0207	0000 7223 83	1)
R 305	1	Schichtwid.	2,61 kΩ / 1% / K1 0,5 / 0309	0000 7166 05	
R 306	1	Schichtwid.	6,088 Ω / 0,5% / 75 mW/Tk 50	0000 7212 16	MLAD
R 307	1	Schichtwid.	5,961 Ω / 0,5% / 75 mW/Tk 50	0000 7212 17	MLAD
R 308	1	Schichtwid.	5,820 Ω / 0,5% / 75 mW/Tk 50	0000 7212 18	MLAD
R 309	1	Schichtwid.	5,694 Ω / 0,5% / 75 mW/Tk 50	0000 7212 19	MLAD
R 310	1	Schichtwid.	5,562 Ω / 0,5% / 75 mW/Tk 50	0000 7212 20	MLAD
R 311	1	Schichtwid.	5,436 Ω / 0,5% / 75 mW/Tk 50	0000 7212 21	MLAD
R 312	1	Schichtwid.	5,307 Ω / 0,5% / 75 mW/Tk 50	0000 7212 22	MLAD
R 313	1	Schichtwid.	5,192 Ω / 0,5% / 75 mW/Tk 50	0000 7212 23	MLAD
R 314	1	Schichtwid.	5,073 Ω / 0,5% / 75 mW/Tk 50	0000 7212 24	MLAD
R 315	1	Schichtwid.	4,954 Ω / 0,5% / 75 mW/Tk 50	0000 7212 25	MLAD
R 316	1	Schichtwid.	212,77 Ω / 0,1% /0,25 W/Tk 50	0000 7212 26	MVAD
R 317	1	Schichtwid.	33 kΩ / 5% / K1 2 / 0309	0000 7100 43	
R 318	1	Schichtwid.	33 kΩ / 5% / K1 2 / 0309	0000 7100 43	
R 319	1	Schichtwid.	34 kΩ / 1% / K1 0,5 / 0309	0000 7167 01	
R 320	1	Schichtwid.	34 kΩ / 1% / K1 0,5 / 0309	0000 7167 01	
R 321	1	Schichtwid.	10,2 kΩ / 1% / K1 0,5 / 0309	0000 7166 57	
R 322	1	Schichtwid.	10,2 kΩ / 1% / K1 0,5 / 0309	0000 7166 57	
R 323	1	Schichtwid.	4,99 kΩ / 0,5% /K1 0,5/0309	0000 7179 35	
R 324	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 325	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	

Serie A: 1) 0,5 % / 75 mW / Tk 50 / MLAD

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 326	1	Schichtwid.	100 Ω / 5% / K1 2 / 0309	0000 7100 13	
R 327	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 328	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 329	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 330	1	Schichtwid.	1,5 kΩ / 5% / K1 2 / 0309	0000 7100 27	
R 331	1	Schichtwid.	1,5 kΩ / 5% / K1 2 / 0309	0000 7100 27	
R 332	1	Schichtwid.	2,61 kΩ / 1% / K1 0,5 / 0309	0000 7166 05	
R 333	1	Schichtwid.	2,61 kΩ / 1% / K1 0,5 / 0309	0000 7166 05	
R 334	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 335	1	Schichtwid.	2,7 kΩ / 5% / K1 2 / 0309	0000 7100 30	
R 336	1	Schichtwid.	560 Ω / 5% / K1 2 / 0309	0000 7100 22	
R 337	1	Schichtwid.	27 kΩ /0,5% / Tk 50/SRA 0207	0000 7223 22	
R 338	1	Schichtwid.	1 kΩ / 5% / K1 2 / 0309	0000 7100 25	
R 339	1	Schichtwid.	8,2 kΩ / 5% / K1 2 / 0309	0000 7100 36	
R 340	1	Schichtwid.	10 kΩ / 5% / K1 2 / 0309	0000 7100 37	
R 341	1	Schichtwid.	82 Ω / 5% / K1 2 / 0309	0000 7100 12	
R 342	1	Schichtwid.	1,2 kΩ / 5% / K1 2 / 0309	0000 7100 26	
R 343	1	Schichtwid.	1,5 kΩ / 1% / K1 0,5 / 0414	0000 7177 37	
R 344	1	Schichtwid.	1,2 kΩ / 5% / K1 2 / 0309	0000 7100 26	
R 345	1	Schichtwid.	2,2 kΩ / 5% / K1 2 / 0309	0000 7100 29	
R 346	1	Schichtwid.	22 kΩ / 5% / K1 2 / 0309	0000 7100 41	
R 347	1	Schichtwid.	12 kΩ / 5% / K1 2 / 0309	0000 7100 38	
R 348	1	Schichtwid.	4,7 kΩ / 5% / K1 2 / 0309	0000 7100 33	
R 349	1	Schichtwid.	1,8 kΩ / 5% / K1 2 / 0309	0000 7100 28	
R 350	1	Schichtwid.	2,2 kΩ / 5% / K1 2 / 0309	0000 7100 29	

EPM-1 BN 564 (3)
Anzeigeschaltung, Ausgangsverstärker (meter circuit, output amplifier)

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
R 351	1	Schichtwid.	15 kΩ / 5% / KT 2 / 0309	0000 7100 39	
R 352	1	Schichtwid.	10 kΩ / 5% / KT 2 / 0309	0000 7100 37	
R 353	1	Schichtwid.	39 kΩ / 5% / KT 2 / 0309	0000 7100 44	
R 354	1	Schichtwid.	4,7 kΩ / 5% / KT 2 / 0309	0000 7100 33	
R 355	1	Schichtwid	47 kΩ / 5% / KT 2 / 0309	0000 7100 45	
R 356	1	Schichtwid.	47 Ω / 5% / KT 2 / 0309	0000 7100 09	
R 357	1	Schichtwid.	68 Ω / 5% / KT 2 / 0719	0000 7101 47	
R 358	1	Schichtwid.	1,82 kΩ / 1% / 0,15 W / Tk 50	0000 7212 27	MLAD
R 359	1	Schichtwid.	470 Ω / 5% / KT 2 / 0309	0000 7100 21	
R 360	1	Schichtwid.	11,6 kΩ / 1% / 0,15 W / Tk 15	0000 7219 32	MVAD
R 361	1	Schichtwid.	3,30 kΩ / 1% / 0,15 W / Tk 15	0000 7219 33	MVAD
R 362	1	Schichtwid.	367,695 Ω / 0,01% /MFE 0809	0000 7212 30	R 16
R 363	1	Schichtwid.	107,696 Ω / 0,01% /MFE 0809	0000 7212 31	R 16
R 364	1	Schichtwid.	130,0 Ω / 0,01% /MFE 0809	0000 7212 32	R 16
R 365	1	Schichtwid.	130,0 Ω / 0,01 % /MFE 0809	0000 7212 32	R 16
R 366	1	Schichtwid.	100 Ω / 5% / KT 2 / 0309	0000 7100 13	
R 367	1	Schichtwid.	22 Ω / 5% / KT 2 / 0309	0000 7100 05	
R 368	1	Schichtwid.	10 Ω / 5% / KT 2 / 0309	0000 7100 01	
R 369	1	Schichtwid.	3,9 kΩ / 5% / KT 2 / 0309	0000 7100 32	Abgleichwert
R 370	1	Schichtwid.	3,9 kΩ / 5% / KT 2 / 0309	0000 7100 32	Abgleichwert
R 371	1	Schichtwid.	1 kΩ / 5% / KT 2 / 0309	0000 7100 25	
R 372	1	Schichtwid.	75 Ω / 0,05 % / MFE 0809	0000 7212 33	R 16
R 373	1	Schichtwid.	1,8 kΩ / 5% / KT 2 / 0309	0000 7100 28	
R 374	1	Schichtwid.	1,8 kΩ / 5% / KT 2 / 0309	0000 7100 28	
R 375	1	Schichtwid.	324 Ω / 1% / Tk 50 / SMA 0207	0000 7224 41	Abgleichwert 1)
P 301	1	Spindelwid.	1 kΩ	0000 7197 42	WN 17 / 4 / 4
P 302	1	Spindelwid.	2 kΩ	0000 7197 43	WN 17 / 4 / 4
P 303	1	Spindelwid.	20 kΩ	0000 7197 46	WN 17 / 4 / 4
P 304	1	Drahtdrehwid.	2,2 kΩ / 10 % / lin.	0000 7213 75	P 4 Achsl. : 30 mm R16
P 305	1	Schichtdrehwid.	25 kΩ / lin / 0,15 W	0000 7213 76	Typ 66 W Nr. 152 Buchsl: 8 mm Achsl:16
P 306	1	Spindelwid.	200 Ω	0000 7197 40	WN 17 / 4 / 4 2)
P 307	1	Spindelwid.	2 kΩ	0000 7197 43	WN 17 / 4 / 4
C 301	1	Kf. - Kond.	0,22 µF / 20 % / 100 V	0000 7107 42	WN 110 / 3 / 7
C 303	1	Kf. - Kond.	0,1 µF / 20 % / 100 V	0000 7107 40	WN 110 / 3 / 7
C 304	1	Kf. - Kond.	0,22 µF / 20 % / 100 V	0000 7107 42	WN 110 / 3 / 7
C 305	1	Kf. - Kond.	0,22 µF / 20 % / 100 V	0000 7107 42	WN 110 / 3 / 7
C 306	1	Elko	1,5 µF / 20 % / 35 V	0000 7206 67	WN 110 / 5 / 61
C 307	1	Elko	47 µF / 20 % / 16 V	0000 7206 62	WN 110 / 5 / 61
G1 301	1	Z - Diode	ZP 10	0000 7123 82	
G1 302	1	Z - Diode	ZP 5,1 rot	0000 7132 23	WN 140 / 3 / 1
G1 303	1	Diode	1 N 4448	0000 7122 76	
G1 304	1	Z - Diode	ZP 6,2	0000 7123 90	

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
G1 305	1	Z - Diode	ZP 6,2	0000 7123 90	
G1 306	1	Diode	1 N 4448	0000 7122 76	
G1 307	1	Diode	1 N 4448	0000 7122 76	
G1 308	1	Diode	1 N 4448	0000 7122 76	
G1 309	1	Z - Diode	ZP 18	0000 7147 53	
G1 310	1	Z - Diode	ZP 15	0000 7123 85	
G1 311	1	Diode	1 N 4448	0000 7122 76	
G1 312	1	Referenzelement	MG 8 V 2	0000 7219 34	
G1 313	1	Z - Diode	ZP 33 (Uz = 33,5 V ± 1% bei Jz = 3 mA)	0000 7219 35	
G1 314	1	Diode	1 N 4448	0000 7122 76	
T 301	1	Transistor	DW 7154	0000 7121 52	
T 302	1	Transistor	DW 7154	0000 7121 52	
T 303	1	Transistor	BCY 59 D	0000 7202 85	
T 304	1	Transistor	BSX 52 A	0000 7121 23	
T 305	1	Transistor	BSX 52 A	0000 7121 23	
T 306	1	Transistor	BSX 52 A	0000 7121 23	
T 307	1	Transistor	BSX 52 A	0000 7121 23	
T 308	1	Transistor	DW 7154	0000 7121 52	
T 309	1	Transistor	BSX 52 A	0000 7121 23	
T 310	1	Transistor	BSX 52 A	0000 7121 23	
T 311	1	Transistor	BCY 59 D	0000 7202 85	
IC 301	1	IC	µA 741 C	0000 7163 43	
IC 302	1	IC	µA 741 C	0000 7163 43	
IC 303	1	IC	µA 741 C	0000 7163 43	
IC 304	1	IC	µA 741 C	0000 7163 43	
IC 305	1	IC	µA 741 C	0000 7163 43	
IC 306	1	IC	µA 741 C	0000 7163 43	
IC 307	1	IC	µA 741 C	0000 7163 43	
IC 308	1	IC	µA 741 C	0000 7163 43	
J 301	1	Instrument		Bv. 564 - 8101	
S1 301	1	Lampe	16 V / 35 mA	0000 7141 95	WN 114 / 1 / 4
S1 302	1	Lampe	12 V / 50 mA	0000 7135 04	WN 114 / 1 / 3 x)
S1 303	1	Lampe	12 V / 50 mA	0000 7135 04	WN 114 / 1 / 3 x)
S 301	1	Schalter		Bv. 564 - 8001	
S 302	1	Schalter	2 x u (Lotfahnen hochgebogen)	0000 7112 05	B 1 WN 13 / 4 / 1
S 303	1	Schalter		Bv. 564 - 8002	
S 304	1	Schalter	1 x u	enthalten in Bu 302	
Bu 301	1	Buchse		0000 3713 00	WN 119 / 1 / 5
Bu 302	1	Buchse		0000 3718 00	4 WN 119 / 1 / 8
Bu 303	1	Buchse	Uni 9 D 1	0000 1669 00	WN 119 / 9 / 4
	1	Übergangsstück		0000 1689 92	7 A WN 119 / 9 / 5

Serie A: 1) entfällt
2) 1 kΩ

x) für J 301

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
R 1	1	Schichtwid.	84,5 Ω / 1% / 75 mW / Tk 50	0000 7219 50	mit Längsschliff MLAD x)
R 2	1	Schichtwid.	130 Ω / 1% / 150 mW / Tk 50	0000 7219 55	mit Längsschliff MLAD
R 4					2)
R 5	1	Schichtwid.	6,8 kΩ / 5% / Kl 2 / 0309		3)
	1	Schichtwid.	680 kΩ / 5% / Kl 2 / 0309		4)
	1	Schichtwid.	680 kΩ / 5% / Kl 2 / 0309		4)
R 8	1	Schichtwid.	Abgleichwert ca. 1 kΩ / 0309		WN 18 / 3 / 1
R 9	1	Schichtwid.	1,21 kΩ / 1% / Kl 0,5 / 0309	0000 7165 79	
P 1	1	Spindelwid.	1 kΩ	0000 7197 42	WN 17 / 4 / 4
P 2	1	Schichtdrehwid.	10 kΩ / lin. / 0,5 W	0000 7104 47	2 WN 17 / 2 / 8
P 3	1	Schichtdrehwid.	100 Ω / lin. / 0,5 W	0000 7104 35	2 WN 17 / 2 / 8
C 1	1	Trimmer	1 ... 3 pF	0000 7220 47	Best. Nr 518 - 600 A Erie
Gl 1					1)
Gl 2					1)

Für Serie A: 1) 1 N 4448 2) 2,7 kΩ / 5% / 0309 3) 2,7 k 4) 3,3 MΩ
x) Drahtenden abgebogen nach Zchng. 572 - 7001.04 / 5

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
T 1 xx)	1	Fototransistor	Mkl - 11		1)
T 2	1	Transistor	BF 245 A	0000 7120 50	
T 3 xx)	1	Fototransistor	Mkl - 11		2)
Th 1 / Th 2	1	Thermokreuzpaar		Bv. 572 - 9301	
Rel 1	1	Relaisspule		Bv. 572 - 8201	
	1	Read - Kontakt		0000 7110 77	WN 118 / 3 / 4
Bu 1 x)	1	Buchse	B 12	0000 7111 61	WN 119 / 7 / 3
St 1	1	Übergangsstück	1,6 / 10 - V : Uni 14 (M) BN 4824 / II	0000 2665 00	

Für Serie A: 1) BPY 60 2) entfällt
x) Bei W.u.G. bearbeitet nach Zchng. 572 - 7004.04 / 5 xx) nach Bv. 572 - 9360 aussuchen

TK-10 BN 572/0
Meßkopf (test probe) 75 Ω

Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
R 1	1	Schichtwid.	84,5 Ω / 1% / 75 mW / Tk 50	0000 7219 50	mit Längsschliff MLAD x)
R 2	1	Schichtwid.	69,8 Ω / 1% / 150 mW / Tk 50	0000 7220 48	mit Längsschliff MLAD
R 3	1	Schichtwid.	562 Ω / 1% / Tk 50 / SMA 0207	0000 7203 79	
R 5	1	Schichtwid.	6,8 kΩ / 5% / Kl 2 / 0309		1)
R 6	1	Schichtwid.	680 kΩ / 5% / Kl 2 / 0309		2)
R 7	1	Schichtwid.	680 kΩ / 5% / Kl 2 / 0309		2)
R 8	1	Schichtwid.	Abgleichwert ca. 1 kΩ / 0309		WN 18 / 3 / 1
R 9	1	Schichtwid.	1,21 kΩ / 1% / Kl 0,5 / 0309	0000 7165 79	
P 1	1	Spindelwid.	1 kΩ	0000 7197 92	WN 17 / 4 / 4
P 2	1	Schichtdrehwid.	10 kΩ / lin. / 0,5 W	0000 7104 47	2 WN 17 / 2 / 8
P 3	1	Schichtdrehwid.	100 Ω / lin. / 0,5 W	0000 7104 35	2 WN 17 / 2 / 8
C 1	1	Trimmer	1 ... 3 pF	0000 7220 47	Best. Nr 518 - 600 A Erie
C 2	1	Trimmer	1 ... 3 pF	0000 7220 47	Best. Nr 518 - 600 A Erie

Für Serie A: 1) 10 kΩ 2) 3,3 MΩ
x) Drahtenden abgebogen nach Zchng. 572 - 7001.04 / 5

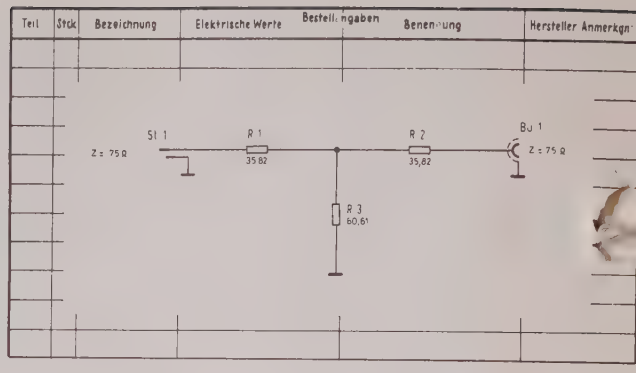
Teil	Stck	Bezeichnung	Bestellangaben: Elektrische Werte	Benennung	Hersteller, Anmerkgn
T 1 xx)	1	Fototransistor	Mkl - 11		
T 2	1	Transistor	BF 245 A	0000 7120 50	
T 3 xx)	1	Fototransistor	Mkl - 11		
Th 1 / Th 2	1	Thermokreuzpaar		Bv. 572 - 9301	
Rel 1	1	Relaisspule		Bv. 572 - 8201	
	1	Read - Kontakt		0000 7110 77	WN 118 / 3 / 4
Bu 1 x)	1	Buchse	B 12	0000 7111 61	WN 119 / 7 / 3
St 1	1	Übergangsstück	N - V : Uni 14 (M) BN 9926 / I	0000 2632 00	

x) Bei W.u.G. bearbeitet nach Zchng. 572 - 7004.04 / 5 xx) nach Bv. 572 - 9360 aussuchen

TK-10 BN 572/1
Meßkopf (test probe) 50 Ω

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 1	1	Stabwid.	35,82 Ω / 1% / 0,25 W	0000 7213 83 Rod Type "I" Part Nr. 125 R 250 CC	*)
R 2	1	Stabwid.	35,82 Ω / 1% / 0,25 W	0000 7213 83 Rod Type "I" Part Nr. 125 R 250 CC	*)
R 3	1	Scheibenwid.	60,61 Ω / 1% / 1 - 2 W	0000 7213 84 Disc Type Part Nr. 75 0 375	*)
Bu 1	1	Übergangsstück	1,6 / 10 - M : Uni 14(M)	BN 4872 / 11 0000 2666 00	
St 1	1	Übergangsstück	1,6 / 10 - V : Uni 14 (M)	BN 4824 / 11 0000 2665 00	

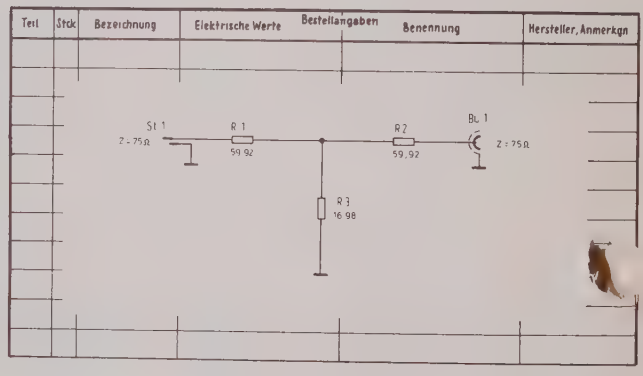
*) Hersteller: Pyrofilm, zu beziehen über Selectron München



BN 594/1
9,03-dB-Dämpfungsglied (9.03 dB attenuation pad) 75 Ω

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 1	1	Stabwid.	59,92 Ω / 1% / 0,25 W	0000 7213 82 Rod Type "I" Part Nr. 125 R 250 CC	*)
R 2	1	Stabwid.	59,92 Ω / 1% / 0,25 W	0000 7213 82 Rod Type "I" Part Nr. 125 R 250 CC	*)
R 3	1	Scheibenwid.	16,98 Ω / 1% / 1 - 2 W	0000 7213 85 Disc Type Part Nr. 75 0 375	*)
Bu 1	1	Übergangsstück	1,6 / 10 - M : Uni 14 (M)	BN 4872 / 11 0000 2666 00	
St 1	1	Übergangsstück	1,6 / 10 - V : Uni 14 (M)	BN 4824 / 11 0000 2665 00	

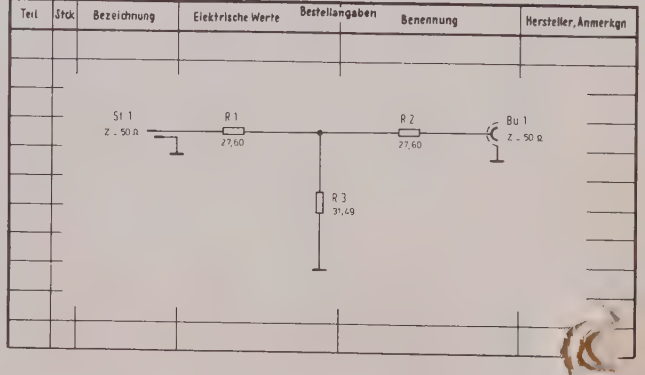
*) Hersteller : Pyrofilm, zu beziehen über Selectron München



BN 594/2
19,03-dB-Dämpfungsglied (19.03 dB attenuation pad) 75 Ω

Teil	Stck	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 1	1	Stabwid.	27,60 Ω / 1% / 0,25 W	0000 7219 64 Rod Type "I" Part Nr. 125 R 250 CC	*)
R 2	1	Stabwid.	27,60 Ω / 1% / 0,25 W	0000 7219 64 Rod Type "I" Part Nr. 125 R 250 CC	*)
R 3	1	Scheibenwid.	31,49 Ω / 1% / 1 - 2 W	0000 7219 65 Disc Type Part Nr: 75 0 375	*)
Bu 1	1	Übergangsstück	N - M : Uni 14 (M)	BN 6928 / 1 0000 2633 00	
St 1	1	Übergangsstück	N - V Uni 14 (M)	BN 9926 / 1 0000 2632 00	

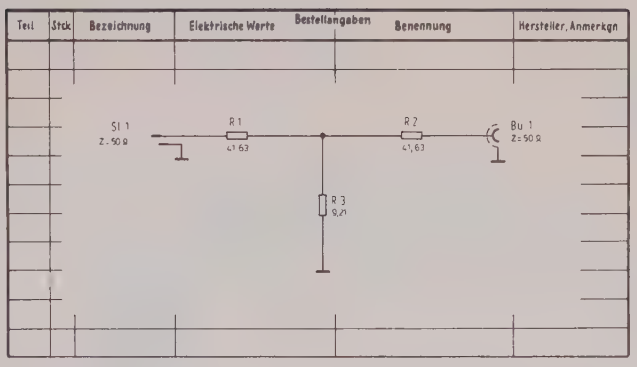
*) Hersteller : Pyrofilm , zu beziehen über Selectron München



BN 594/3
10,79-dB-Dämpfungsglied (10.79 dB attenuation pad) 50 Ω

Teil	Stck.	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 1	1	Stabwid.	41,63 Ω / 1% / 0,25 W	0000 7219 66 Rod Type "T" Part Nr. 125 R 250 CC	*)
R 2	1	Stabwid.	41,63 Ω / 1% / 0,25 W	0000 7219 66 Rod Type "T" Part Nr. 125 R 250 CC	*)
R 3	1	Scheibenwid.	9,21 Ω / 1% / 1 - 2 W	0000 7219 67 Disc Type Part Nr. 75 D 375	*)
	1	Übergangsstück	N - V : Uni 14 (M) BN 6928 / I	0000 2633 00	
St 1	1	Übergangsstück	N - V : Uni 14 (M) BN 9926 / I	0000 2632 00	

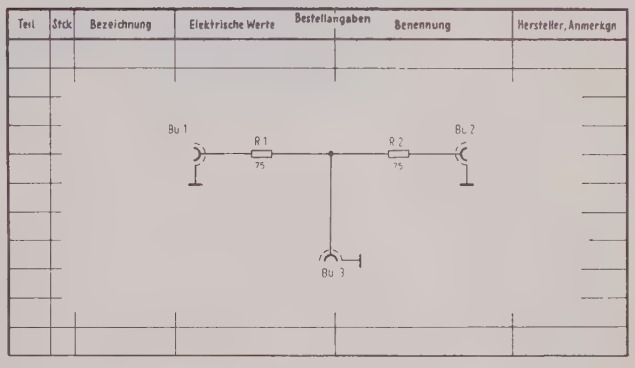
*) Hersteller : Pyrofila , zu beziehen über Selectron München



BN 594/4
20,79-dB-Dämpfungsglied (20.79 dB attenuation pad) 50 Ω

Teil	Stck.	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 1	1	Stabwid.	75 Ω / 1 % / 0,25 W	0000 7213 81 Rod Type "T" Part Nr. 125 R 250 CC	*)
R 2	1	Stabwid.	75 Ω / 1 % / 0,25 W	0000 7213 81 Rod Type "T" Part Nr. 125 R 250 CC	*)
	1	Übergangsstück	1,6 / 10 - M : Uni 14 (M)	BN 4872 / 11 0000 2666 00	
	1	Übergangsstück	1,6 / 10 - M : Uni 14 (M)	BN 4872 / 11 0000 2666 00	
Bu 3	1	Übergangsstück	1,6 / 10 - M : Uni 14 (M)	BN 4872 / 11 0000 2666 00	

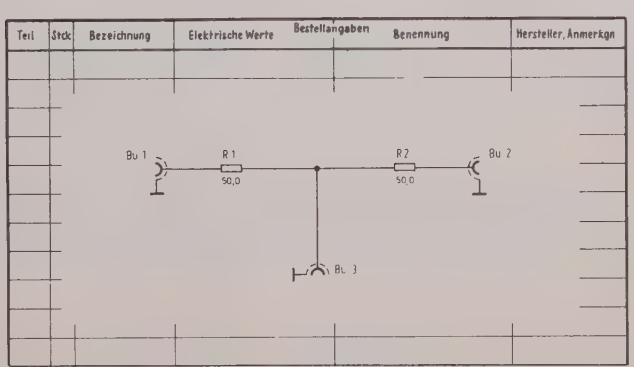
*) Hersteller : Pyrofila , zu beziehen über Selectron München.



BN 595/1
T-Verzweigung (T-pad) 75 Ω

Teil	Stck.	Bezeichnung	Elektrische Werte	Bestellangaben Benennung	Hersteller, Anmerkgn
R 1	1	Stabwid.	50,0 Ω / 1% / 0,25 W	0000 7219 68 Rod Type "T" Part Nr. 125 R 250 CC	*)
R 2	1	Stabwid.	50,0 Ω / 1% / 0,25 W	0000 7219 68 Rod Type "T" Part Nr. 125 R 250 CC	*)
Bu 1	1	Übergangsstück	N - M : Uni 14 (M)	BN 6928 / I 0000 2633 00	
Bu 2	1	Übergangsstück	N - M : Uni 14 (M)	BN 6928 / I 0000 2633 00	
	1	Übergangsstück	N - M : Uni 14 (M)	BN 6928 / I 0000 2633 00	

*) Hersteller : Pyrofila , zu beziehen über Selectron München



BN 595/2
T-Verzweigung (T-pad) 50 Ω

TECHNICAL BULLETIN

EPM-1
MILLIWATT TEST SET
DESCRIPTION, APPLICATION, SPECS

- Frequency range: d.c.; 10 Hz to 300 MHz
- High absolute accuracy of level measurement
- Excellent resolution, expanded mode of ± 0.2 dB full scale
- High relative accuracy on expanded scale
- True r.m.s. measuring, independent of signal wave form
- Calibration with built-in calibration source for 0 dBm and 0 dB
- Overload proof through protective circuit which makes it a reliable testroom instrument of highest precision
- Application as constant level amplifier for voltage stabilization of a Generator's output
- Option for balanced measurements

GENERAL

The Milliwatt Test Set EPM-1 is a wide-band level measuring instrument for the frequency range 10 Hz to 300 MHz. It is principally used for extremely accurate r.m.s. value measurements of the levels 0 dBm and 0 dB (774.6 mV) in telecommunications systems. Not only measuring levels but also calibrating noise sources and checking the accuracy of calibration of level measuring instruments are possible. Moreover, the EPM-1 can be operated as an auxiliary constant-level amplifier (see applications on pages 4 and 5).

Due to the Test Probe TK-10 being connected to the Milliwatt Test Set by means of a cable, it is possible to pick up the measured signal right at the point of interest in the circuit. Thereby, extra test cables are not required, and cable attenuation and connection discontinuities which might affect the accuracy of measurement are prevented.

501 - Dec. 1974

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The input impedance is either 75 Ω or 50 Ω. If balanced measurements are to be made, then the Test Probe TKS-10 is available, if ordered, with corresponding measurement circuitry and calibrating adaptors for 124, 150 and 600 Ω. The frequency ranges according to the pertinent impedance are: 10 Hz to 12 MHz, 10 Hz to 2 MHz or 10 Hz to 20 kHz respectively.

The measurement range is switchable in 0.2 dB steps from - 1 dBm to + 1 dBm on an expanded scale. A protective circuit protects the thermocouple from being overloaded, and a signal light indicates if an overload has occurred. The calibration of the EPM-1 is accomplished by the use of an extremely accurate internal d.c. voltage which is brought out to a chassis connector at an output impedance of 0 Ω or 75 Ω, or if requested, 50 Ω.

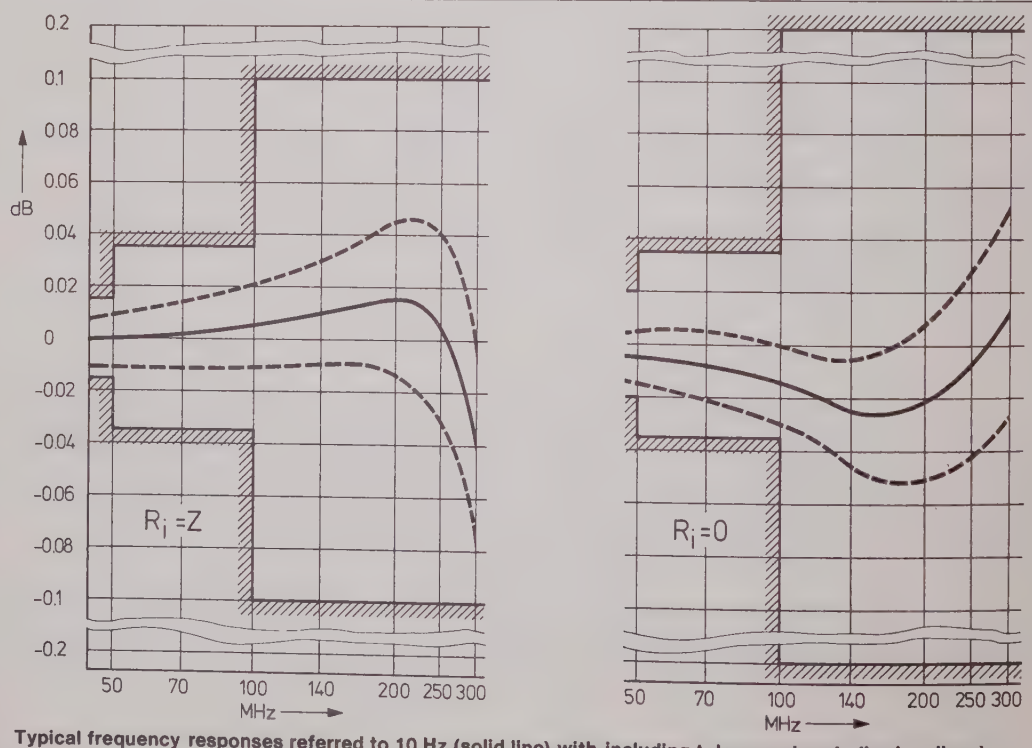
TECHNICAL DETAILS

The Milliwatt Test Set EPM-1 utilizes the Test Probe TK-10 or TKS-10 as a transducer. With this Test Probe, the test signal is taken off directly at the measurement point of interest. The thermocouple within the Test Probe measures the heat resulting from the dissipation of electric power. Therefore, the wave form of the signal being measured has no affect on the measured result. The Milliwatt Test Set always measures the true r.m.s. value of the test signal.

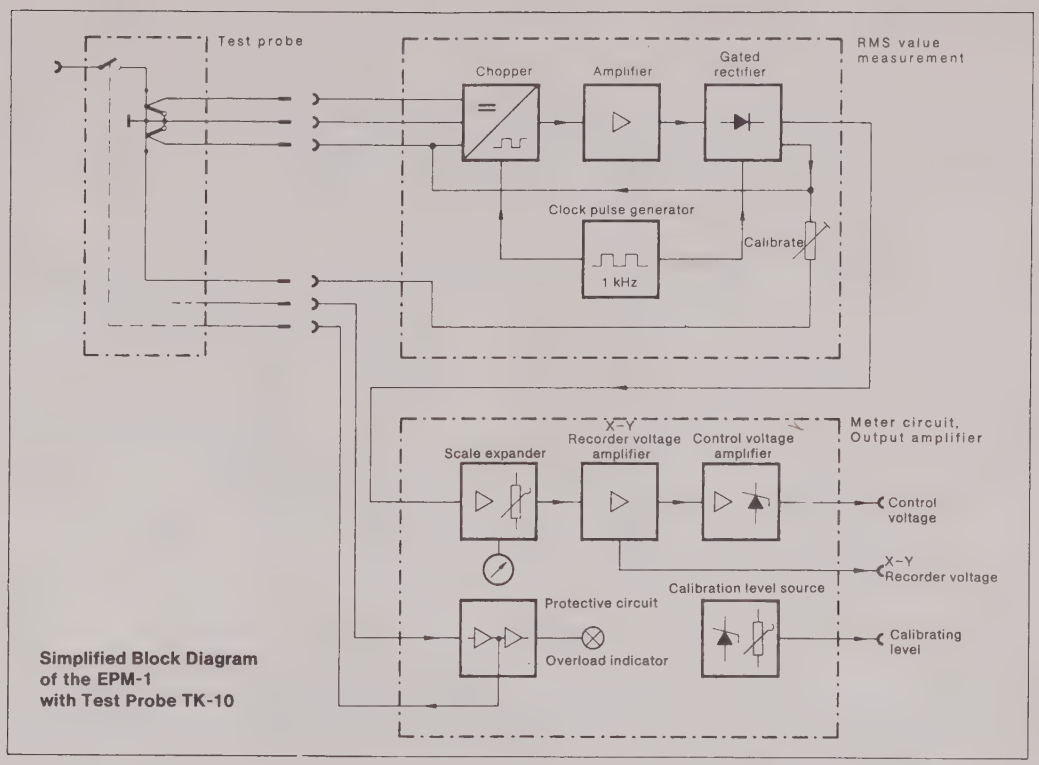
Since the transducer is directly placed in the Test Probe, there is no need for input cables. These cables can cause appreciable attenuation and mismatch effects at the intended frequency range.

The temperature dependence of the measuring thermocouple is compensated through the arrangement of a reference thermocouple which is directly adjacent to the measuring thermocouple.

For every TK-10 Test Probe, there is an individual calibration chart prepared and delivered with the Test Probe. This chart ensures an exact view of the frequency response error of the Test Probe. With the aid of the calibration table, it is possible to limit the frequency response error and thereby further increase the measuring accuracy. Both of the thermocouples, the chopper, the chopper amplifier and the gated rectifier, form a closed-loop control circuit which restabilizes to the difference between both thermocouple voltages. See block diagram.



Typical frequency responses referred to 10 Hz (solid line), with including tolerance bands (broken lines)



Simplified Block Diagram of the EPM-1 with Test Probe TK-10

The voltages generated by the thermocouples are of opposite polarity. Through the chopper, these voltages are alternately applied to the input of the amplifier. The differential voltage is amplified and then is evaluated by a gated rectifier.

The d.c. voltage at the output of the rectifier is fed back to the reference thermocouple and is changed in value until the voltage difference becomes zero between both thermocouples. If there is a change in voltage from the measuring thermocouple, then there is a proportional change in the voltage at the output of the rectifier. The rectifier output voltage can be directly applied to the meter. A simultaneous and equal change in value of both measuring and reference thermocouple voltage does not cause any change in the output voltage from the rectifier. That is, it is not indicated on the meter. By this method, the temperature dependence of the measuring thermocouple is thoroughly compensated.

The recorder voltage amplifier enables driving an X-Y recorder with the d.c. voltage output which is proportional to the meter reading.

When the EPM-1 is operated as an automatic gain control amplifier (see applications on pages 4 and 5), the d.c. voltage which is proportional to the test signal is fed to a differential amplifier having a second input from an adjustable reference voltage. At the output of this amplifier, the error voltage is taken for the signal generator which is to be controlled.

For calibrating the equipment, a calibration level is produced. This highly constant d.c. voltage is derived from a silicon reference element.

A protective circuit disconnects the input if the measuring thermocouple is overloaded with an excessive input signal.

The impendance of the test probe can be verified without external equipment.

APPLICATIONS

1. Application as reference level meter

The Reference Level Meter EPM-1 has a major application in monitoring signal levels with great precision. For example, it can be used to measure and observe the power levels 0 dBm = 1 mW, or by means of an attenuator pad in the RF path , to measure the voltage level 0 dB (774.6 mV) or + 10 dB (2.45 V).

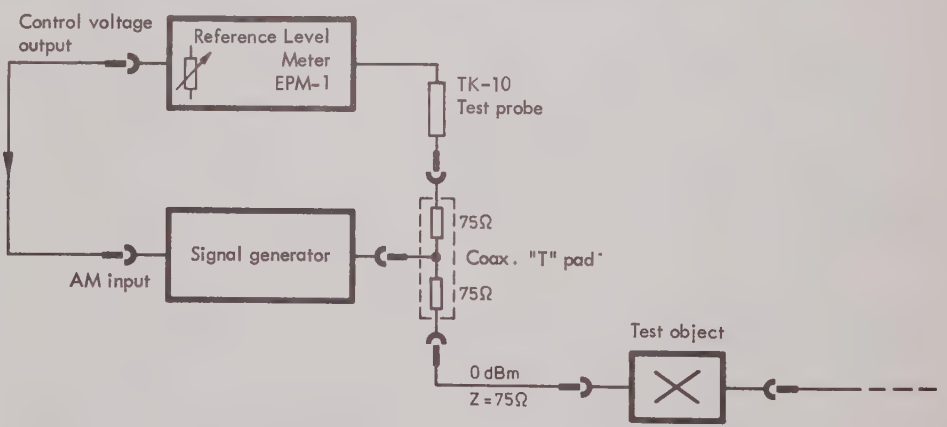
Furthermore, it is not necessary to examine the waveform of the observed signal because the EPM-1 measures the heating value and thereby gives a true r.m.s. value of the signal.

The EPM-1 has important applications in various fields. For example, the following measurements are possible:

- Routine measurements and check-out procedures of the 0-dBm-level on carrier frequency and microwave link radio systems.
- Calibration of noise sources and retesting the r.m.s. values of various voltage sources.
- Monitoring the calibration of level measuring instruments.

2. Application as constant level amplifier

An interesting application of the EPM-1 is possible if it is used as a constant level amplifier. The EPM-1 in conjunction with a level generator or signal generator form a closed loop control circuit. Most of the W&G level generators can be used for this application.



By means of a special coaxial "T" pad, which has two 75 Ω branches, the signal generator is coupled to the test object by one of the branches, and to the test probe of the EPM-1 by the other 75 Ω branch.

One of the outputs of the EPM-1 is available on the front panel via banana jacks. It supplies a d.c. control voltage which is proportional to the difference between an adjustable reference value and the real value of the measured level (the polarity of this output can be changed). This voltage can be coupled to the d.c. coupled "AM" modulation input of a signal generator. As can be seen from Fig. 1, the application of the EPM-1 in this configuration forms a closed loop AGC (automatic gain control circuit) with the result that the voltage is constant at the junction point of the special coaxial "T" network and is independent of the chosen frequency. The remaining error depends only on the accuracy of the probe (see specifications of EPM-1).

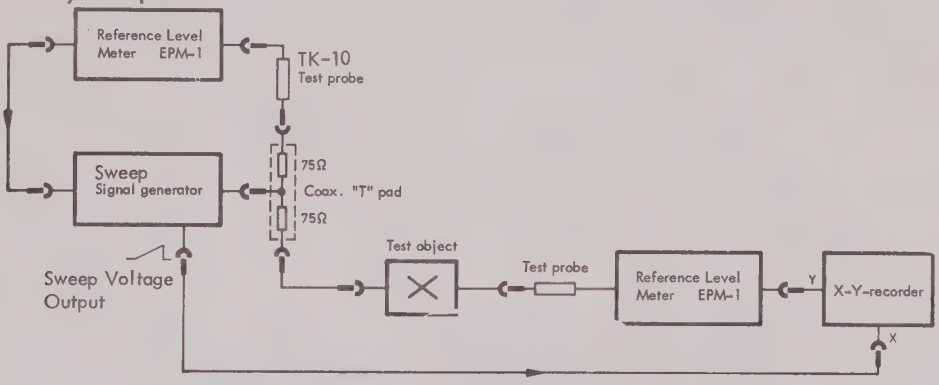
Additional advantages:

- The error caused by the signal generator output impedance is eliminated.

- The generator voltage can be adjusted with extremely fine control because the reference voltage of the EPM-1 is varied by means of a high quality potentiometer.

- Attenuation networks can be used for measurements at all frequencies, and the generator level of 0 dB (774.6mV) as well as + 10 dB (2.45 V) can be held constant. The attenuator networks are available as accessories and can be ordered from W&G Instruments, Inc.

3. Frequency response measurements with two EPM-1 units



The picture illustrates an elegant arrangement for the time saving and rational recording of amplitude versus frequency. By this method, one EPM-1 is used as a constant level amplifier for the sweep frequency generator, and the other EPM-1 is used for the measurement of the output power of the test object. The X-Y recorder receives its vertical deflection signal from the recorder output of the EPM-1 and the horizontal deflection signal is obtained directly from the sweep generator.

All essential characteristics of our instruments are indicated by guaranteed tolerance and limit specifications and not as typical values. They are valid for each instrument not only on delivery but also for the whole guarantee period.

In so far as there are no special notations, after one hour of operating time, the given values are valid for the rated operating range of the a.c. power line voltage, the a.c. frequency and the ambient temperature.

Frequency

Frequency range . . . . . d.c., 10 Hz to 300 MHz

Input

(through Test Probe TK-10)

Input impedance Z . . . . . two versions, either 75 Ω or 50 Ω

Return loss coefficient of the input:

to 50 MHz	≦ 0.005
to 100 MHz	≦ 0.010
to 200 MHz	≦ 0.030
to 300 MHz	≦ 0.050

Largest permissible input voltage . . . . . V_{rms} = 3 V

Permitted crest factor of the test level . . . . . ≦ 10[1]

Overloaded indication for thermocouple . . . . . with signal lamp

Connector for Test Probe input:

with Z = 75 Ω	(IEC 75-7) 1.6/10 (M)
with Z = 50 Ω	Type "N" connector (M)

Measurement ranges

Unexpanded scales . . . . . 0 dBm; ± 1 dB

Expanded scales . . . . . −1; −0.8 . . . +1 dBm; ± 0.2 dB

Meter Accuracy

Accuracy limits of a 0 dBm reading: measurement range 0 dBm ± 0.2 dB, after calibration, for ambient temperature (23 ± 3) °C, taking in consideration the individually given frequency response error of every Test Probe[2], for Z_{out} = Z and Z_{out} = 0[3]

in the frequency range:

10 Hz to 50 MHz	± 0.015 dB
at 100 MHz	± 0.025 dB
at 200 MHz	± 0.040 dB
at 300 MHz	± 0.050 dB

Accuracy limits of reading over the total range (expanded or unexpanded) after calibration in the rated operating range of the ambient temperature with consideration of the individually given variations over frequency of every test probe[2], for Z_{out} = Z and Z_{out} = 0[3]

in the frequency range:

10 Hz to 50 MHz	± 0.035 dB
at 100 MHz	± 0.045 dB
at 200 MHz	± 0.060 dB
at 300 MHz	± 0.070 dB

Maximum variation over frequency of reading referred to 10 Hz[2]

with source Z_{out} = Z:

to 50 MHz	± 0.015 dB
to 100 MHz	± 0.035 dB
to 200 MHz	± 0.060 dB
to 300 MHz	± 0.100 dB

with source Z_{out} = 0[3]:

to 50 MHz	± 0.020 dB
to 100 MHz	± 0.035 dB
to 200 MHz	± 0.120 dB
to 300 MHz	± 0.200 dB

Affect of equipment temperature on reading . . . . . less than 0.0015 dB/°C

Affect of Test Probe temperature on reading . . . . . less than 0.003 dB/°C

Outputs

Calibration level output (d.c. voltage)

Selectable calibration level with Z_{out} = Z and Z_{out} = 0 . . . 0 dBm across Z and 0 dB

Accuracy limits of calibration level at 23° C . . . . . ± 0.005 dB

Maximum variation of calibration level with temperature . . . . within 0.001 dB/°C

Graphic recorder voltage output (short circuit proof)

Open circuit voltage, unexpanded scale . . . . . approx. 0.25 V/0.1 dB

expanded scale . . . . . approx. 1.25 V/0.1 dB

Output impedance . . . . . 5 kΩ

---

1) The crest factor is the ratio of the peak value to the r.m.s. value of a voltage.

2) The variations over frequency, referred to 10 Hz, are individually given for each Test Probe at the frequencies: 50, 70, 100, 140, 200, 250 and 300 MHz. Intermediate values of the variations with frequency or the warrented accuracy limits can be calculated by interpolation.

3) The measured values are valid for an electrical gradiant in a cable which is 15 mm in electrical length before the connection plane of the Test Probe. (Reference plane is at the common earth point for a 1.6/10 and Type "N" connector.) The error caused by the reflection coefficient need not be additionally considered.

Meanings of abbreviations: (M) = male; (F) = female

Control voltage output for stabilizing a generator (short circuit proof)
Adjustable (open circuit voltage) . . . . approx. 30 mV/0.01 dB to 300 mV/0.01 dB
Setting range . . . . . greater than ± 2 V
Polarity . . . . . switchable
Output impedance . . . . . approx. 500 Ω

General Specifications

Permissible ambient temperature
Range for storage and transport . . . . . −40 to +70° C
Rated operating range . . . . . +5 to +40° C

Power supply
Rated operating range of a.c. power line voltage . . . 110/117/128/220/227/238 V −15%/+10%
Rated operating range of a.c. power frequency . . . . . 45 to 66 Hz
Power consumption . . . . . 16 VA
Safety class of VDE[1] I

Dimensions

Width with swing handle . . . . . 256 mm
Height overall . . . . . 244 mm
Depth overall . . . . . 370 mm
(suitable for mounting in 19" rack according to DIN 41 494)
Weight . . . . . 7 kg

Measurement Accessories

Balanced Measurents Test Probe TKS-10
(preliminary specifications)

Balanced Measurements Test Probe TKS-10, utilizes for adapting to the pertinent impedance the Test Probe Adaptor TKSA- . . . and the Calibration Adapter TKSE- . . .

Frequency ranges: Z = 124 Ω . . . . . d.c., 10 Hz to 12 MHz
Z = 150 Ω . . . . . d.c., 10 Hz to 2 MHz
Z = 600 Ω . . . . . d.c., 10 Hz to 20 kHz

Maximum variation of reading with frequency, referred to f = 1 kHz at Z_{out} = Z . . . . . +0.02/−0.03 dB
Return loss coefficient of the input . . . . . less than 0.01

Accuracy limits of the reading 0 dBm:
in measuring range 0 dBm ± 0.2 dB, after calibration,
for ambient temperature of (23 ± 3) °C at f = 1 kHz . . . . . ± 0.01 dB

Accuracy limits of the readings within complete range of levels,
(expanded or unexpanded), after calibration, within rated operating range
of ambient temperature for Z_{out} = Z and f = 1 kHz . . . . . ± 0.03 dB

Common mode rejection, f ≦ 0.3 MHz . . . . . 50 dB
f ≦ 10 MHz . . . . . 40 dB

Attenuation Networks
(for TK-10)

Frequency range . . . . . d.c. to 300 MHz

Max. variation with frequency of the insertion loss, referred to d.c.
to 100 MHz . . . . . ± 0.01 dB
to 300 MHz . . . . . ± 0.03 dB

Return loss coefficient to:
100 MHz . . . . . not greater than 0.01
300 MHz . . . . . not greater than 0.03

Largest permissible input power: BN 594/1 and 594/3 . . . . . 0.5 W
BN 594/2 and 594/4 . . . . . 0.3 W

Permissible ambient temperature
Limit range for storage and transport . . . . . −40 to +70° C
Rated range of use . . . . . +5 to +40° C

"T" pads
(for TK-10)

Frequency range . . . . . d.c. to 300 MHz

Voltage difference between both outputs when terminated with Z:
with d.c. . . . . not greater than 0.100 dB
additionally: at 100 MHz . . . . . not greater than 0.005 dB
at 300 MHz . . . . . not greater than 0.010 dB

Maximum loading of termination . . . . . 0.25 W

Permissible ambient temperature
Limit range for storage and transport . . . . . −40 to +70° C
Rated range of use . . . . . +5 to +40° C

Adaptors
Couplings

See under Ordering Information

1) Verein Deutscher Elektrotechniker (Institute of German Electrical Engineers)

Ordering Information

CAL OUTPUT
IN R_1 0 = .27386

CAL OUTPUT
IN R_1 75Ω = .54758

Milliwatt Test Set EPM-1 (basic unit):		75 Ω version	BN 564/0
		50 Ω version	BN 564/1
Test Probe TK-10		75 Ω version	BN 572/0
		50 Ω version	BN 572/1
For balanced measurements:			
Test Probe	TKS-10		BN 668
Test Probe adaptor	TKSA-124, Z = 124 Ω		BN 668/10
	TKSA-150, Z = 150 Ω		BN 668/11
	TKSA-600, Z = 600 Ω		BN 668/12
Calibration adaptor	TKSE-124, Z = 124 Ω		BN 668/20
	TKSE-150, Z = 150 Ω		BN 668/21
	TKSE-600, Z = 600 Ω		BN 668/22

Attenuation networks

Impedance	Connector	Insertion loss for d.c. voltage	Order No.
75 Ω	1.6/10 (F) – 1.6/10 (M)	9.03 dB ± 0.15 dB	BN 594/1
		19.03 dB ± 0.20 dB	BN 594/2
50 Ω	N-Conn. (F) – N-Conn. (M)	10.79 dB ± 0.15 dB	BN 594/3
		20.79 dB ± 0.20 dB	BN 594/4

"T" pads

Impedance	Connector	Order No.
75 Ω 50 Ω	(IEC 75-7) 1.6/10 (F) Type N-Connector (F)	BN 595/1 BN 595/2

Adaptors

Impedance	Connector		Return loss coefficient at 100 MHz/300 MHz	Order No.
75 Ω	1.6/10 (F) to	BNC (M)	0.02/0.04	S 391
		BNC (F)		S 392
		2.5/6 (M)	0.03/0.05	S 393
		2.5/6 (F)		S 394
		1.6/5.6 (M)	0.015/0.03	S 395
		1.6/5.6 (F)		S 396
		WE 440 A (M)	0.01/0.02	S 397
		WE 558 A (F)		S 398
		WE 358 A (M)	0.01/0.02	S 399
		WE 470 C (F)		S 400
50 Ω	N-Conn. (F) to	BNC (M)	0.01/0.025	S 407
		BNC (F)		S 408
		4.1/9.5 (M)	0.01/0.01	S 409
		4.1/9.5 (F)		S 410
		7/16 (M)	0.01/0.01	S 18
		7/16 (F)		S 17
		C-Conn. (M)	0.01/0.015	S 411
		C-Conn. (F)		S 412

Couplings

75 Ω 50 Ω	1.6/10 (M) – 1.6/10 (M) N-Conn. (M) – N-Conn. (M)	0.01/0.015	S 390 S 406

Key for abbreviation: (M) = male ; (F) = female

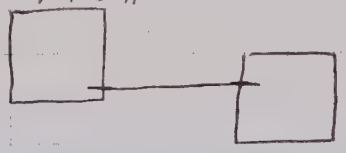
ORDERING INFORMATION

For reprints of this technical bulletin: Order Technical Bulletin 501-EPM-1. (Small quantities available at no charge.

Send order to:

W&G Instruments, Inc.
119 Naylon Avenue
Livingston, New Jersey 07039
or call (201) 994-0854

A.C. CALIBRATOR
HP 745A



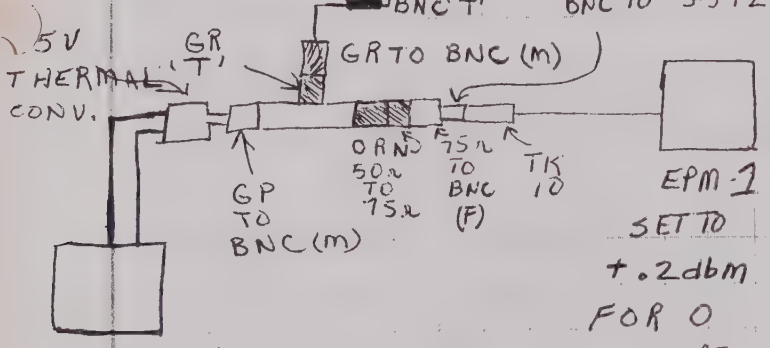
(NO TERMINATIONS)

EPM-1

EPM-1 INPUT FREQ. FROM AC CAL WITH VOLTAGE OUTPUT OF .27386 V	EPM-1 READING AT 0dbm
10 Hz	-.001
100 Hz	-.003
1 KHz	-.003
10 KHz	-.005
100 KHz	-.004
50 Hz	-.007
500 Hz	-.006
5 KHz	-.006
50 KHz	-.005

HP 3450A
.88504 V

652A TEST OSC.
1 KHz



HOLD THIS READING THRU Δ FREQ

652A FREQ (Δ) HOLDING FLK READOUT CONST.	EPM-1 READOUT SET TO +.2dbm
1 KHz	.000
10 KHz	.000
100 KHz	.000
1 MHz	.000
10 MHz	.002
100 Hz	.004
10 Hz	.005
5 MHz	.004
500 KHz	.004
50 KHz	.003
5 KHz	.002
500 Hz	.002
50 Hz	.002

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7410 Reutlingen

Technical Information

Wolfram Nebel

HINTS ON THE APPLICATION OF THE MILLIWATT TEST SET EPM-1

PRELIMINARY NOTES

The Milliwatt Test Set is a highly accurate instrument which can be used for tasks in three areas of measuring:

- Wideband level meter covering the frequency range 10 Hz to 300 MHz, mainly measuring the exact level in the region of 0 dBm on transmission systems.

- Reference instrument to calibrate sources which may have any type of output signal (sinusoidal, noise, data signals) because a true r.m.s. measurement is made. Checking of level measuring sets is another application.

- Automatic gain control amplifier in conjunction with a suitable signal generator. The result is an exceptionally stable output level.

Wideband Level Meter

The Milliwatt Test Set EPM-1 is an r.m.s. value measuring instrument. To obtain the value of the input signal, the value is converted into the related heating power. For this measuring method, the heating power is directly proportional to the r.m.s. value of the signal. Thus, the waveshape of the input signal has no effect. The EPM-1 range, covering 10 Hz up to 300 MHz, permits wideband measurements to be made. Thus,the measurement of the level 0 dBm or - by means of a corresponding attenuator (BN 594) - measurements of the level 0 dB and 10 dB are possible each with a max. deviation of ± 1 dB. An expanded scale and the possibility of switching in 0.2 dB increments enable the full utilization of the instrument's accuracy. Due to the handy dimensions and the low weight, the Milliwatt Test Set is especially suitable to be used as an item of service equipment.

Reference Instrument

The EPM-1 is also especially suitable to be used as a reference instrument for the calibration of noise sources, of level generators or of level measuring instruments.

Herewith, the principles of the preceeding overview are explained as follows:
The measurements require a measuring instrument with constant input impedance Z_{in} and with indication of the level 0 dBm at Z_{in}. These requirements are outstandingly fulfilled by the EPM-1. By means of the Test Probe, it is possible to reduce to a minimum the errors which are caused by unavoidable attenuation of the test cable and by mismatching: because the measuring transducer is connected directly to the instrument being measured. The cable connecting the Test Probe to the evaluation instrument is only utilized for d.c. signals.

Calibrating a Generator at 0 dBm

Self-calibration of the EPM-1 at 0 dBm

The calibration level switch is set at 0 dBm/Z_{out} = Z_L. The measurement mode switch is switched to the red mark, 0 dBm. Now the Test Probe is directly connected to connector OUTPUT. There, the calibrating level is at 0 dBm. Potentiometer CALIBRATE is used to bring to zero the reading of the meter.

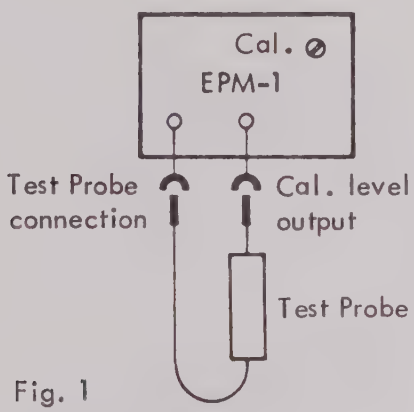

Fig. 1

Calibrating the Generator (test specimen) at 0 dBm

The settings of the EPM-1 are not changed, and the Test Probe is directly applied to the output which is to be measured at the test specimen. If the output level of the test specimen is adjusted so the analog meter of the EPM-1 is again zero, then the test specimen has been calibrated for 0 dBm at Z_L.

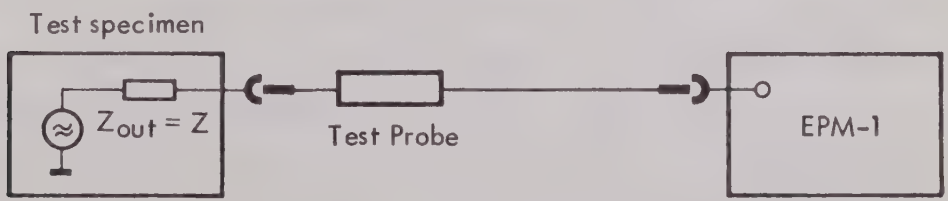

Fig. 2

Calibrating a Generator at 0 dB

With the calibration at voltage level 0 dB (≙ 0.7746 V), the following differences are to be observed:

a) Usually when the EPM-1 is self-calibrated and when calibrating a signal generator, the Test Probe (see above) is to be used with a plug-in type of 9.03 dB attenuation network.

b) With self-calibration, the calibration level switch is switched to the 0 dB range, $Z_{out} = 0$; other than that the preceeding is completely the same.

c) When calibrating the test specimen (Generator) it is necessary to observe if it is really delivering a voltage level (dB) and at which reference value of load impedance.

Calibrating a Level Meter with the EPM-1 at 0 dBm

The calibration of a Level Meter is done in three steps whereby an auxiliary generator is used. The steps are described as follows:

Self-calibration of the EPM-1 at 0 dBm

The first step is done exactly as described in the paragraph "Self-calibration of the EPM-1".

Calibrating an auxiliary generator

The adjustments on the EPM-1 are not changed, and the Test Probe via a coaxial cable is connected to the auxiliary generator. The coaxial cable must have a characteristic impedance corresponding to the output impedance of the auxiliary generator tuned to the frequency of calibration. Now, the output level of the auxiliary generator can be adjusted. The auxiliary generator delivers 0 dBm at the calibration frequency when the meter of the EPM-1 indicates 0 dBm.

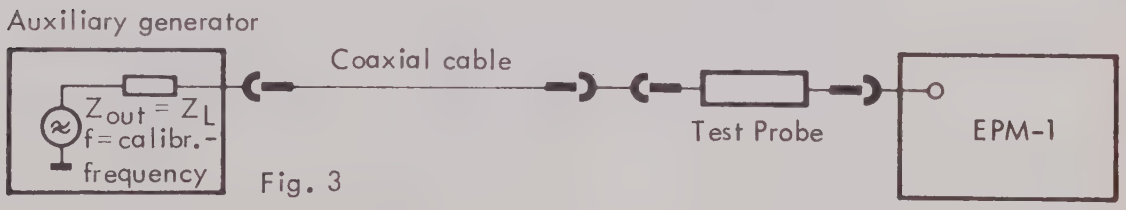

Fig. 3

Calibrating the Level Meter (test specimen) at 0 dBm

The adjustments at the auxiliary generator are not changed. Instead of the Test Probe, the coaxial cable used when calibrating the auxiliary generator is now connected to the Level Meter (test specimen) which then by means of its controls is adjusted to 0 dBm.

Fig. 4

Calibrating a Level Meter at 0 dB (≅ 0.7746 V)

The same points of view as explained in the paragraph "Calibrating a Generator at 0 dB" are to be observed.

Use of the Test Probes

Transmission system	for self-calibrating an EPM-1	for calibrating the test specimen
Coaxial cable	TK-10 [1]	TK-10 [1]
Balanced line	TKS-10 + TKSA-... + TKSE-... [2]	TKS-10 + TKSA-... [2]

1) TK-10 in the version corresponding to the impedance of the EPM-1 (50 Ω, 75 Ω).

2) TKSA-..., TKSE-... with the impedance of the corresponding line (124 Ω, 150 Ω, 600 Ω) e.g. TKSA-150 and TKSE-150.

Caution: Possible only with EPM-1/75 Ω version (BN 564/0) and with the special version (BN 564/3).

Application as constant level amplifier

An additional interesting application of the EPM-1 is the use as a constant level amplifier. In this type of application, the Milliwatt Test Set combined with the signal generator (or level sender) forms a closed loop control circuit. As prerequisites, however, the signal generator must have either a d.c. coupled A.M. input or a control voltage input. And the signal generator must provide output power of at least + 6 dBm. These prerequisites are fulfilled with Wandel u. Goltermann's Level Generators PS-5, PS-6, PS-7 and PS-60.

The signal generator delivers an exactly defined power which is applied in equal quantities via a "T" network to both the test specimen and the EPM-1 operating as a control amplifier. From the control voltage output of the EPM-1, the signal

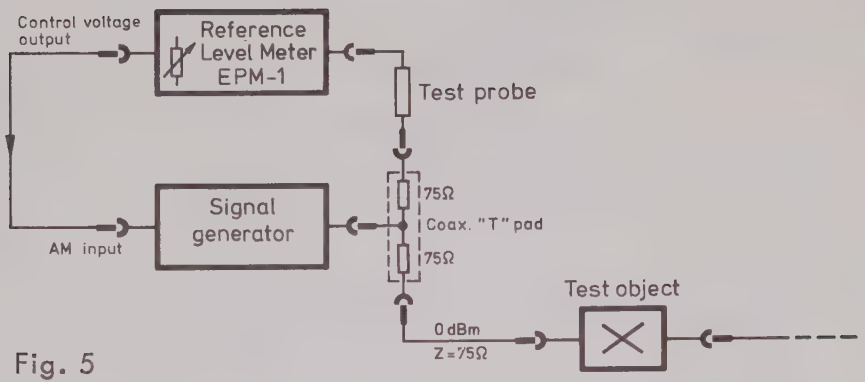

Fig. 5

generator is supplied with signal-drive through the AM input. This drive signal is a d.c. voltage proportional to the deviation of the true signal from the nominal signal. By means of this automatic control, the output power is held constant over the complete frequency range. Therefore, this constant output almost completely removes the output error due to the variation of level with frequency of the signal generator, and the generator output impedance error is eliminated. The residual error is in the order of 10^{-3}, and is introduced only by the variation with frequency of the Test Probe and other causes: for example, minor instability of the EPM-1 and unsymmetry in the "T" network. The magnitude of the sender level can be adjusted with great precision by means of changing the reference voltage within the EPM-1 with the corresponding potentiometer.

If output voltages of 0 dB or + 10 dB from a generator are to be held constant, then for level matching, a corresponding attenuation network should be connected ahead od the Test Probe.

The hum voltage, which could appear between the chassis ground of the EPM-1 and the chassis ground of the generator being controlled, is applied to the AM input of the sender if both equipment chassis grounds are directly connected. The send signal is then modulated, as a result, so the hum voltage appears as modulation at the level output of the sender.

For reducing this possible error to a minimum, a decoupling resistor of 100 Ω is added in series with the intrinsic cable resistance of 1 Ω, as shown in Fig. 6. And thereby the hum voltage is reduced to approx. 1 % of that at the control voltage output.

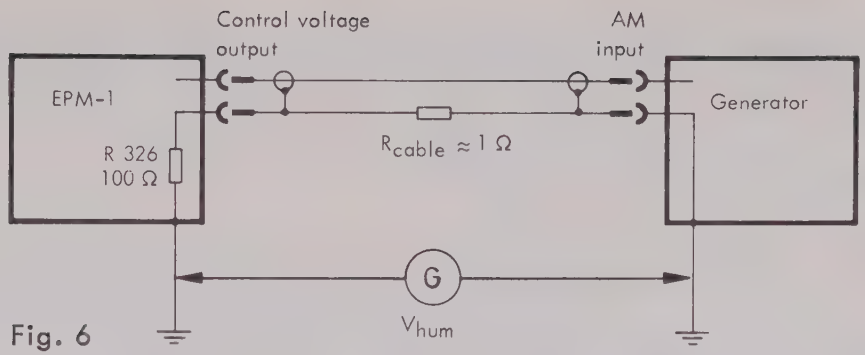

Fig. 6

As an example, the variation of level with frequency of a Level Generator PS-6 is plotted with and without automatic control of this type. The already extremely good frequency response of the PS-6 has a scattering of ± 0.02 dB in the range from 6 kHz to 18 MHz, and this is reduced to less than ± 0.002 dB. The negligible superimposed noise which is visible only due to the high resolution is a consequence of the measuring principle and cannot be eliminated.

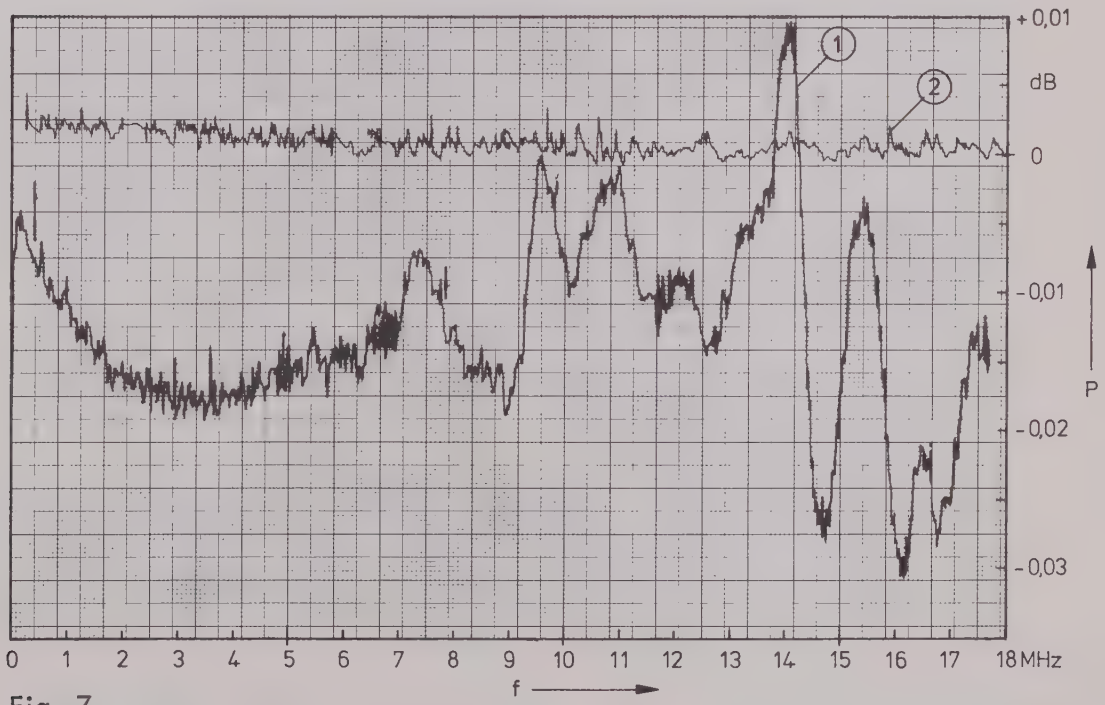

Fig. 7

Improving the stability of a Level Generator PS-6 through the application of an EPM-1 as a constant level amplifier.

(1): unstabilized (2): stabilized

Measuring the variation of level with frequency of a test specimen

Two Milliwatt Test Sets EPM-1 can permit an accurate measurement of variation of level with frequency of a test specimen. Fig. 8 despicts the arrangement for graphically recording variations with frequency.

Thus, one EPM-1 is used as a constant level amplifier for the signal generator, and the other EPM-1 is used for measuring the output power from the test specimen. The X-Y recorder obtains the signal for vertical deflection from the EPM-1 recorder output, and the signal for the horizontal deflection is directly provided by the sweep output from the signal generator.

To eliminate the still remaining individual variations with frequency introduced by the two Test Probes used in the configuration, it is recommended that first the variation of level with frequency be determined without the test specimen but with the two Test Probes. This determination furnishes the difference in variation of level with frequency introduced by the Test Probes.

Then, when the test specimen is in the configuration, measuring for the variation of level with frequency provides apparent frequency response from which is subtracted the response of the Test Probes. Therefore, the true variation with frequency of the test specimen has been obtained.

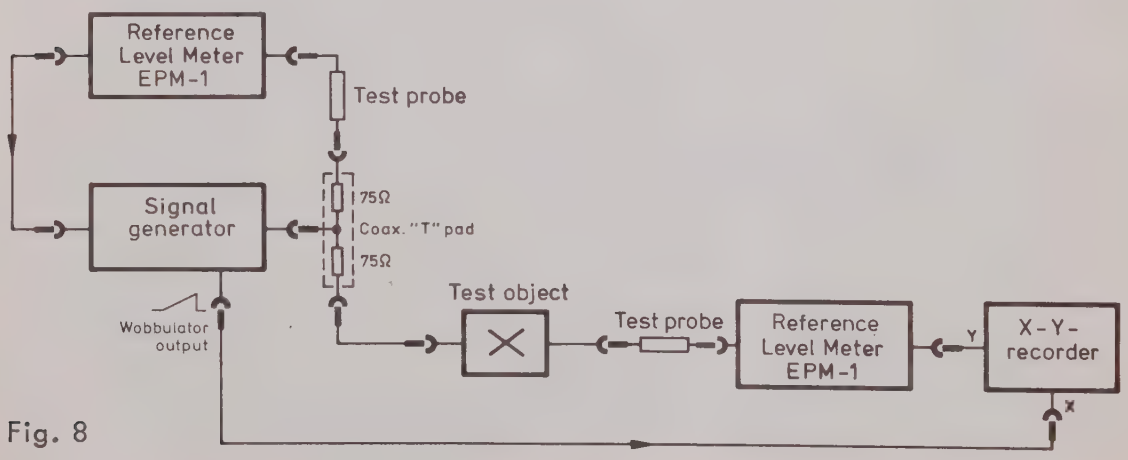

Fig. 8

When frequencies are swept, both the EPM-1 as well as the X-Y recorder time constants must have values in the order of 1 s.

The sweep rate can be checked with the following method: when the selected sweep rate is reduced to 1/2, variations in frequency response of the stabilized signal generator may appear only within the required measuring accuracy.

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Wandel u. Goltermann
7410 Reutlingen

Technical Information

Wolfram Nebel

NEW SERIES OF TEST PROBES FOR OPERATING THE EPM-1 WITH BALANCED SYSTEMS

In the past, only a Test Probe (TK-10/BN 572) with the EPM-1 was available for measurements on coaxial lines. Now we can also offer Test Probes for balanced systems with impedances (Z_o = 124 Ω, 150 Ω, and 600 Ω). Test Probes of this series can be used without constraints with the 75 Ω-versions of the EPM-1 (BN 564/0) and (BN 564/3). In conjunction with the 50 Ω-version (BN 564/1), the Test Probe also may be directly calibrated with the impedances Z_o = 124 Ω and 150 Ω. However, the 600 Ω Test Probe must be calibrated with an external calibrating level of 0 dB at Z_{out} = 75 Ω.
Test Probes for measurements on balanced lines consist of three elements:

- Balanced Test Probe TKS-10 (BN 668):
  Basic part identical to TK-10 except for the arrangement of the thermocouple. The balanced input is obtained through the two connectors of the thermocouple being accessible from the outside.
- Test Probe Adapter TKSA...:
  for adapting the Test Probe TKS-10 to the impedance of the system to be measured.

The following versions are available:
TKSA-124 (BN 668/10): Z_o = 124 Ω, (d.c.; 10 Hz to 12 MHz)
TKSA-150 (BN 668/11): Z_o = 150 Ω, (d.c.; 10 Hz to 2 MHz)
TKSA-600 (BN 668/12): Z_o = 600 Ω, (d.c.; 10 Hz to 20 kHz)

- Calibration Adapter TKSE...:

  for adjusting the calibration level of the EPM-1 to the calibration level required by the Test Probe (TKS plus TKSA).

The following versions are available:

TKSE-124 (BN 668/20): Z_o = 124 Ω

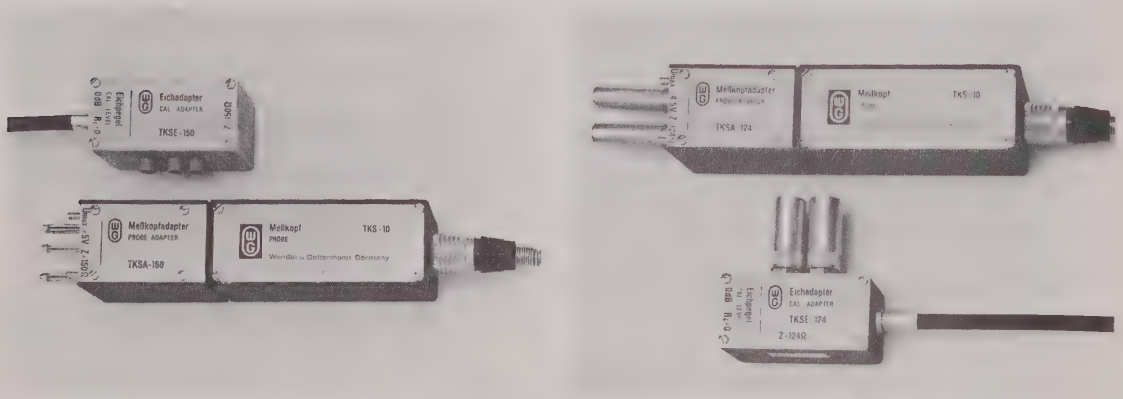
TKSE-150 (BN 668/21): Z_o = 150 Ω

TKSE-600 (BN 668/22): Z_o = 600 Ω

Together with EPM-1/75 Ω version (BN 564/0) these Test Probes enable measurements on balanced lines and test specimens of all commonly occurring impedances.

A special storage case for the component parts is included in the standard package (no extra charge).

For measurements on coaxial cables TK-10 is still available in the version 75 Ω (BN 572/0) and in the version 50 Ω (BN 572/1).



Balanced Test Probe TKS-10 with Test Probe Adapter and Calibration Adapter

THE MOST IMPORTANT ADVANTAGES OF EPM-1

The Milliwatt Test Set EPM-1 is a highly precise instrument which is mainly used for three different tasks:

- Wideband Level Meter covering the frequency range 10 Hz to 300 MHz; particularly for measuring the exact level in the region of 0 dBm on transmission systems.
- Reference instrument for the calibration of noise sources and for the highly precise verification of the calibration of level measuring instruments.
- Automatic gain control amplifier (e.g. for the exact measurement of variations with frequency.

In order to reduce to a minimum the errors at high frequency, e.g. introduced through attenuation and mismatch of the cables, it is of advantage to place the Probe as close as possible to the test point being measured. With the EPM-1, this is realized by means of the Test Probes. The electric power converted to an equivalent temperature is measured by the internal thermocouple within these Test Probes; i.e. the r.m.s. value of the test signal. Therefore the wave shape of the signal has no effect. Due to the thermocouples having been mounted as one pair, the influence of the temperature on the Test Probe is nearly compensated. Through a protective circuit, the Test Probe can be overloaded up to 10 times with respect to the voltage level and up to 100 times with respect to the power level.

Due to the increased possibilities introduced with the accessories for EPM-1, measurements can be made on balanced as well as on unbalanced systems. Herewith, this Milliwatt Test Set although of a very high precision is the most universal instrument presently available.

0.15. 5.75 139

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2428

TECHNICAL BULLETIN

EPM-1
MILLIWATT TEST SET
DESCRIPTION, APPLICATION, SPECS

- Frequency range: d.c.; 10 Hz to 300 MHz
- High absolute accuracy of level measurement
- Excellent resolution, expanded mode of ± 0.2 dB full scale
- High relative accuracy on expanded scale
- True r.m.s. measuring, independent of signal wave form
- Calibration with built-in calibration source for 0 dBm and 0 dB
- Overload proof through protective circuit which makes it a reliable testroom instrument of highest precision
- Application as constant level amplifier for voltage stabilization of a Generator's output
- Option for balanced measurements

0.27386 V
0.77460 V

GENERAL

The Milliwatt Test Set EPM-1 is a wide-band level measuring instrument for the frequency range 10 Hz to 300 MHz. It is principally used for extremely accurate r.m.s. value measurements of the levels 0 dBm and 0 dB (774.6 mV) in telecommunications systems. Not only measuring levels but also calibrating noise sources and checking the accuracy of calibration of level measuring instruments are possible. Moreover, the EPM-1 can be operated as an auxiliary constant-level amplifier (see applications on pages 4 and 5).

Due to the Test Probe TK-10 being connected to the Milliwatt Test Set by means of a cable, it is possible to pick up the measured signal right at the point of interest in the circuit. Thereby, extra test cables are not required, and thus cable attenuation and connection discontinuities which might affect the accuracy of measurement are prevented.

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The input impedance is either 75 Ω or 50 Ω. If balanced measurements are to be made, then the Test Probe TKS-10 is available, if ordered, with corresponding measurement circuitry and calibrating adaptors for 124, 150 and 600 Ω. The frequency ranges according to the pertinent impedance are: 10 Hz to 12 MHz, 10 Hz to 2 MHz or 10 Hz to 20 kHz respectively.

The measurement range is switchable in 0.2 dB steps from - 1 dBm to + 1 dBm on an expanded scale. A protective circuit protects the thermocouple from being overloaded, and a signal light indicates if an overload has occurred. The calibration of the EPM-1 is accomplished by the use of an extremely accurate internal d.c. voltage which is brought out to a chassis connector at an output impedance of 0 Ω or 75 Ω, or if requested, 50 Ω.

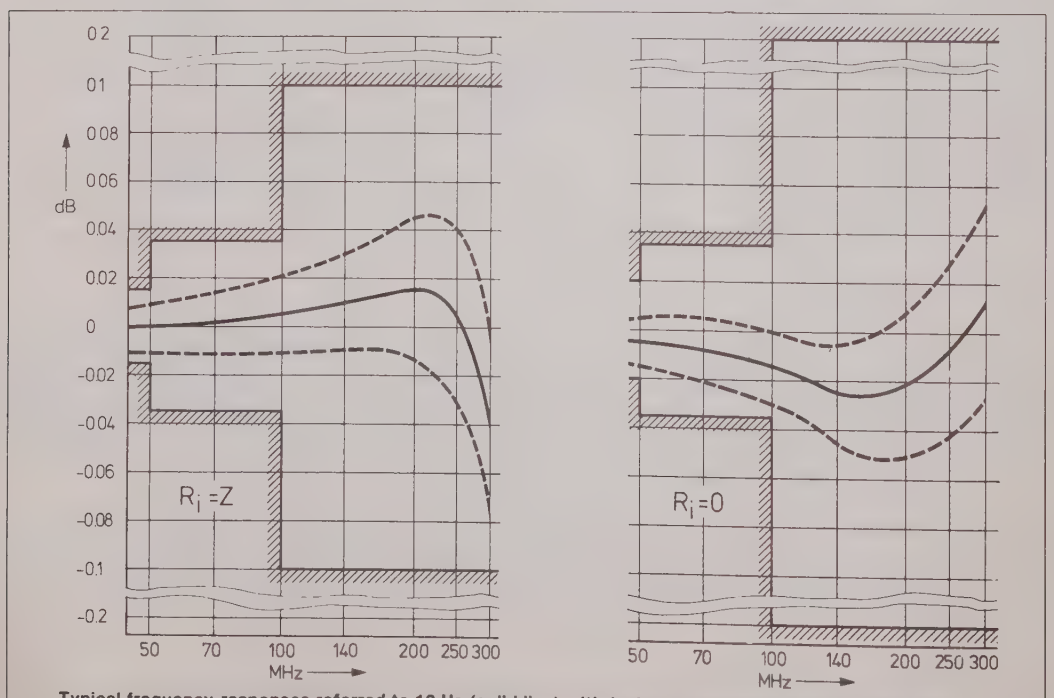
TECHNICAL DETAILS

The Milliwatt Test Set EPM-1 utilizes the Test Probe TK-10 or TKS-10 as a transducer. With this Test Probe, the test signal is taken off directly at the measurement point of interest. The thermocouple within the Test Probe measures the heat resulting from the dissipation of electric power. Therefore, the wave form of the signal being measured has no affect on the measured result. The Milliwatt Test Set always measures the true r.m.s. value of the test signal.

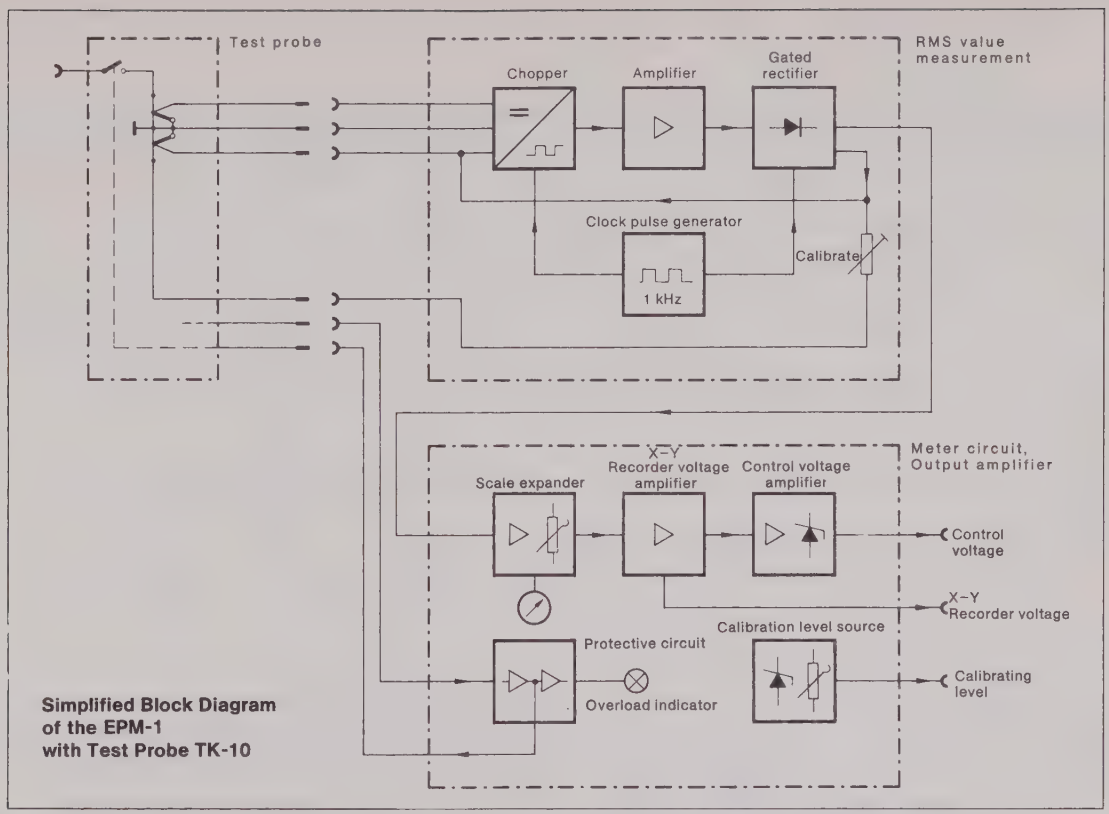
Since the transducer is directly placed in the Test Probe, there is no need for input cables. These cables can cause appreciable attenuation and mismatch effects at the intended frequency range.

The temperature dependence of the measuring thermocouple is compensated through the arrangement of a reference thermocouple which is directly adjacent to the measuring thermocouple.

For every TK-10 Test Probe, there is an individual calibration chart prepared and delivered with the Test Probe. This chart ensures an exact view of the frequency response error of the Test Probe. With the aid of the calibration table, it is possible to limit the frequency response error and thereby further increase the measuring accuracy. Both of the thermocouples, the chopper, the chopper amplifier and the gated rectifier, form a closed-loop control circuit which restabilizes to the difference between both thermocouple voltages. See block diagram.



Typical frequency responses referred to 10 Hz (solid line), with including tolerance bands (broken lines)



Simplified Block Diagram of the EPM-1 with Test Probe TK-10

The voltages generated by the thermocouples are of opposite polarity. Through the chopper, these voltages are alternately applied to the input of the amplifier. The differential voltage is amplified and then is evaluated by a gated rectifier.

The d.c. voltage at the output of the rectifier is fed back to the reference thermocouple and is changed in value until the voltage difference becomes zero between both thermocouples. If there is a change in voltage from the measuring thermocouple, then there is a proportional change in the voltage at the output of the rectifier. The rectifier output voltage can be directly applied to the meter. A simultaneous and equal change in value of both measuring and reference thermocouple voltage does not cause any change in the output voltage from the rectifier. That is, it is not indicated on the meter. By this method, the temperature dependence of the measuring thermocouple is thoroughly compensated.

The recorder voltage amplifier enables driving an X-Y recorder with the d.c. voltage output which is proportional to the meter reading.

When the EPM-1 is operated as an automatic gain control amplifier (see applications on pages 4 and 5), the d.c. voltage which is proportional to the test signal is fed to a differential amplifier having a second input from an adjustable reference voltage. At the output of this amplifier, the error voltage is taken for the signal generator which is to be controlled.

For calibrating the equipment, a calibration level is produced. This highly constant d.c. voltage is derived from a silicon reference element.

A protective circuit disconnects the input if the measuring thermocouple is overloaded with an excessive input signal.

The impendance of the test probe can be verified without external equipment.

APPLICATIONS

1. Application as reference level meter

The Reference Level Meter EPM-1 has a major application in monitoring signal levels with great precision. For example, it can be used to measure and observe the power levels 0 dBm = 1 mW, or by means of an attenuator pad in the RF path , to measure the voltage level 0 dB (774.6 mV) or + 10 dB (2.45 V).

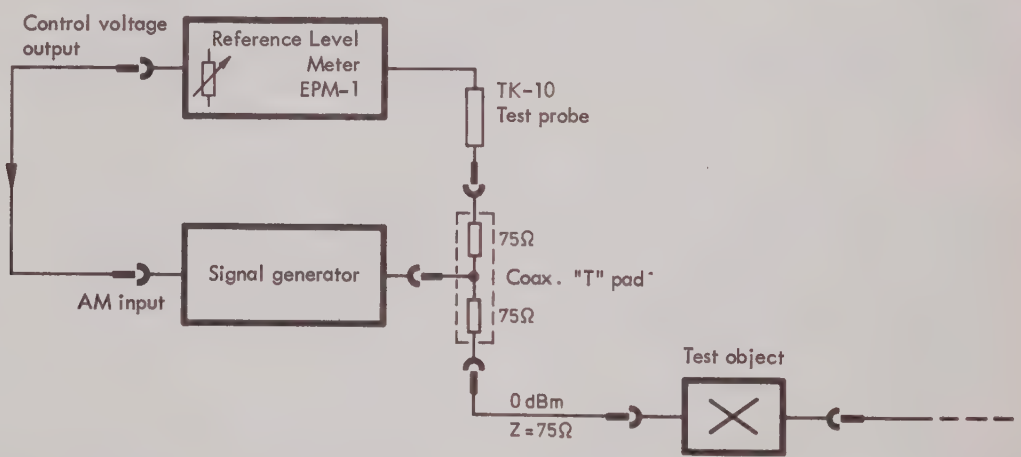
Furthermore, it is not necessary to examine the waveform of the observed signal because the EPM-1 measures the heating value and thereby gives a true r.m.s. value of the signal.

The EPM-1 has important applications in various fields. For example, the following measurements are possible:

- Routine measurements and check-out procedures of the 0-dBm-level on carrier frequency and microwave link radio systems.
- Calibration of noise sources and retesting the r.m.s. values of various voltage sources.
- Monitoring the calibration of level measuring instruments.

2. Application as constant level amplifier

An interesting application of the EPM-1 is possible if it is used as a constant level amplifier. The EPM-1 in conjunction with a level generator or signal generator form a closed loop control circuit. Most of the W&G level generators can be used for this application.



By means of a special coaxial "T" pad, which has two 75 Ω branches, the signal generator is coupled to the test object by one of the branches, and to the test probe of the EPM-1 by the other 75 Ω branch.

One of the outputs of the EPM-1 is available on the front panel via banana jacks. It supplies a d.c. control voltage which is proportional to the difference between an adjustable reference value and the real value of the measured level (the polarity of this output can be changed). This voltage can be coupled to the d.c. coupled "AM" modulation input of a signal generator. As can be seen from Fig. 1, the application of the EPM-1 in this configuration forms a closed loop AGC (automatic gain control circuit) with the result that the voltage is constant at the junction point of the special coaxial "T" network and is independent of the chosen frequency. The remaining error depends only on the accuracy of the probe (see specifications of EPM-1).

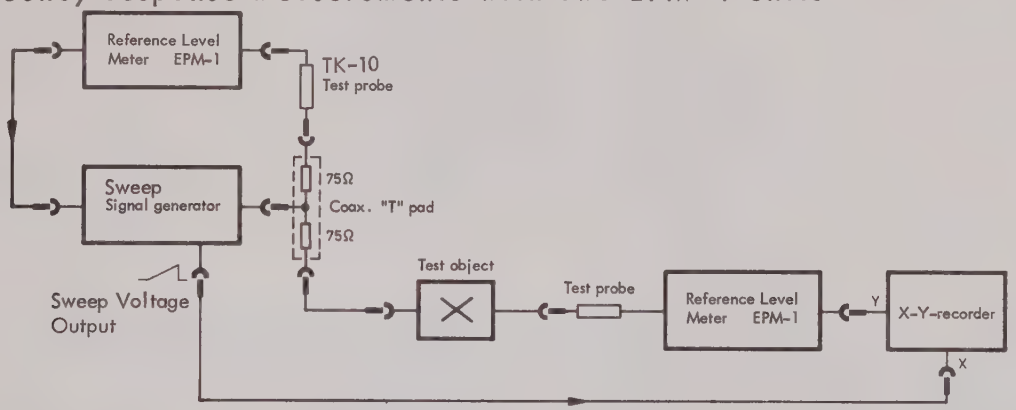
Additional advantages:

- The error caused by the signal generator output impedance is eliminated.

- The generator voltage can be adjusted with extremely fine control because the reference voltage of the EPM-1 is varied by means of a high quality potentiometer.

- Attenuation networks can be used for measurements at all frequencies, and the generator level of 0 dB (774.6mV) as well as + 10 dB (2.45 V) can be held constant. The attenuator networks are available as accessories and can be ordered from W&G Instruments, Inc.

3. Frequency response measurements with two EPM-1 units



The picture illustrates an elegant arrangement for the time saving and rational recording of amplitude versus frequency. By this method, one EPM-1 is used as a constant level amplifier for the sweep frequency generator, and the other EPM-1 is used for the measurement of the output power of the test object. The X-Y recorder receives its vertical deflection signal from the recorder output of the EPM-1 and the horizontal deflection signal is obtained directly from the sweep generator.

All essential characteristics of our instruments are indicated by guaranteed tolerance and limit specifications and not as typical values. They are valid for each instrument not only on delivery but also for the whole guarantee period.

In so far as there are no special notations, after one hour of operating time, the given values are valid for the rated operating range of the a.c. power line voltage, the a.c. frequency and the ambient temperature.

Frequency

Frequency range . . . . . d.c., 10 Hz to 300 MHz

Input

(through Test Probe TK-10)

Input impedance Z . . . . . two versions, either 75 Ω or 50 Ω

Return loss coefficient of the input:

to 50 MHz	≦0.005
to 100 MHz	≦0.010
to 200 MHz	≦0.030
to 300 MHz	≦0.050

Largest permissible input voltage . . . . . V_{rms} = 3 V

Permitted crest factor of the test level . . . . . ≦10[1]

Overloaded indication for thermocouple . . . . . with signal lamp

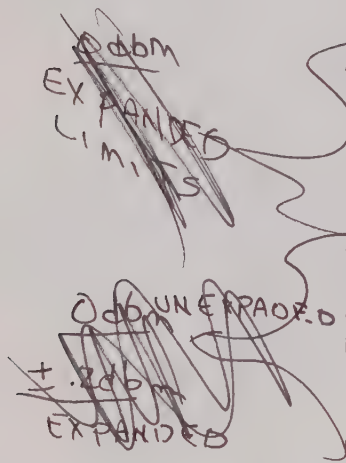
Connector for Test Probe input:

with Z = 75 Ω	(IEC 75-7) 1.6/10 (M)
with Z = 50 Ω	Type "N" connector (M)

Measurement ranges

Unexpanded scales . . . . . 0 dBm; ±1 dB

Expanded scales . . . . . −1; −0.8...+1 dBm; ± 0.2 dB



Meter Accuracy

Accuracy limits of a 0 dBm reading: measurement range 0 dBm ± 0.2 dB, after calibration, for ambient temperature (23 ± 3) °C, taking in consideration the individually given frequency response error of every Test Probe[2], for Z_{out} = Z and Z_{out} = 0[3]

in the frequency range:

10 Hz to 50 MHz	± 0.015 dB
at 100 MHz	± 0.025 dB
at 200 MHz	± 0.040 dB
at 300 MHz	± 0.050 dB

Accuracy limits of reading over the total range (expanded or unexpanded) after calibration in the rated operating range of the ambient temperature with consideration of the individually given variations over frequency of every test probe[2], for Z_{out} = Z and Z_{out} = 0[3]

in the frequency range:

10 Hz to 50 MHz	± 0.035 dB
at 100 MHz	± 0.045 dB
at 200 MHz	± 0.060 dB
at 300 MHz	± 0.070 dB

Maximum variation over frequency of reading referred to 10 Hz[2]

with source Z_{out} = Z:

to 50 MHz	± 0.015 dB
to 100 MHz	± 0.035 dB
to 200 MHz	± 0.060 dB
to 300 MHz	± 0.100 dB

with source Z_{out} = 0[3]:

to 50 MHz	± 0.020 dB
to 100 MHz	± 0.035 dB
to 200 MHz	± 0.120 dB
to 300 MHz	± 0.200 dB

Affect of equipment temperature on reading . . . . . less than 0.0015 dB/°C

Affect of Test Probe temperature on reading . . . . . less than 0.003 dB/°C

Outputs

Calibration level output (d.c. voltage)

Selectable calibration level with Z_{out} = Z and Z_{out} = 0 . . . 0 dBm across Z and 0 dB

Accuracy limits of calibration level at 23° C . . . . . ± 0.005 dB

Maximum variation of calibration level with temperature . . . . within 0.001 dB/°C

Graphic recorder voltage output (short circuit proof)

Open circuit voltage, unexpanded scale . . . . . approx. 0.25 V/0.1 dB

expanded scale . . . . . approx. 1.25 V/0.1 dB

Output impedance . . . . . 5 kΩ

1) The crest factor is the ratio of the peak value to the r.m.s. value of a voltage.
2) The variations over frequency, referred to 10 Hz, are individually given for each Test Probe at the frequencies: 50, 70, 100, 140, 200, 250 and 300 MHz. Intermediate values of the variations with frequency or the warrented accuracy limits can be calculated by interpolation.
3) The measured values are valid for an electrical gradiant in a cable which is 15 mm in electrical length before the connection plane of the Test Probe. (Reference plane is at the common earth point for a 1.6/10 and Type "N" connector.) The error caused by the reflection coefficient need not be additionally considered.

Meanings of abbreviations: (M) = male; (F) = female

Control voltage output for stabilizing a generator (short circuit proof)
Adjustable (open circuit voltage) . . . . approx. 30 mV/0.01 dB to 300 mV/0.01 dB
Setting range . . . . . greater than ± 2 V
Polarity . . . . . switchable
Output impedance . . . . . approx. 500 Ω

General Specifications

Permissible ambient temperature
Range for storage and transport . . . . . −40 to +70° C
Rated operating range . . . . . +5 to +40° C

Power supply
Rated operating range of a.c. power line voltage . . . 110/117/128/220/227/238 V −15%/+10%
Rated operating range of a.c. power frequency . . . . . 45 to 66 Hz
Power consumption . . . . . 16 VA
Safety class of VDE[1] I

Dimensions

Width with swing handle . . . . . 256 mm
Height overall . . . . . 244 mm
Depth overall . . . . . 370 mm
(suitable for mounting in 19" rack according to DIN 41 494)
Weight . . . . . 7 kg

Measurement Accessories

Balanced Measurents Test Probe TKS-10
(preliminary specifications)

Balanced Measurements Test Probe TKS-10, utilizes for adapting to the pertinent impedance the Test Probe Adaptor TKSA- . . . and the Calibration Adapter TKSE- . . .

Frequency ranges: Z = 124 Ω . . . . . d.c., 10 Hz to 12 MHz
Z = 150 Ω . . . . . d.c., 10 Hz to 2 MHz
Z = 600 Ω . . . . . d.c., 10 Hz to 20 kHz

Maximum variation of reading with frequency, referred to f = 1 kHz at Z_{out} = Z . . . . . +0.02/−0.03 dB
Return loss coefficient of the input . . . . . less than 0.01

Accuracy limits of the reading 0 dBm:
in measuring range 0 dBm ± 0.2 dB, after calibration,
for ambient temperature of (23 ± 3) °C at f = 1 kHz . . . . . ± 0.01 dB

Accuracy limits of the readings within complete range of levels, (expanded or unexpanded), after calibration, within rated operating range of ambient temperature for Z_{out} = Z and f = 1 kHz . . . . . ± 0.03 dB

Common mode rejection, f ≦ 0.3 MHz . . . . . 50 dB
f ≦ 10 MHz . . . . . 40 dB

Attenuation Networks
(for TK-10)

Frequency range . . . . . d.c. to 300 MHz

Max. variation with frequency of the insertion loss, referred to d.c.
to 100 MHz . . . . . ± 0.01 dB
to 300 MHz . . . . . ± 0.03 dB

Return loss coefficient to:
100 MHz . . . . . not greater than 0.01
300 MHz . . . . . not greater than 0.03

Largest permissible input power: BN 594/1 and 594/3 . . . . . 0.5 W
BN 594/2 and 594/4 . . . . . 0.3 W

Permissible ambient temperature
Limit range for storage and transport . . . . . −40 to +70° C
Rated range of use . . . . . +5 to +40° C

"T" pads
(for TK-10)

Frequency range . . . . . d.c. to 300 MHz

Voltage difference between both outputs when terminated with Z:
with d.c. . . . . not greater than 0.100 dB
additionally: at 100 MHz . . . . . not greater than 0.005 dB
at 300 MHz . . . . . not greater than 0.010 dB

Maximum loading of termination . . . . . 0.25 W

Permissible ambient temperature
Limit range for storage and transport . . . . . −40 to +70° C
Rated range of use . . . . . +5 to +40° C

Adaptors
Couplings

See under Ordering Information

1) Verein Deutscher Elektrotechniker (Institute of German Electrical Engineers)

Ordering Information

Milliwatt Test Set EPM-1 (basic unit):	75 Ω version	BN 564/0
	50 Ω version	BN 564/1
Test Probe TK-10	75 Ω version	BN 572/0
	50 Ω version	BN 572/1
For balanced measurements:		
Test Probe	TKS-10	BN 668
Test Probe adaptor	TKSA-124, Z = 124 Ω	BN 668/10
	TKSA-150, Z = 150 Ω	BN 668/11
	TKSA-600, Z = 600 Ω	BN 668/12
Calibration adaptor	TKSE-124, Z = 124 Ω	BN 668/20
	TKSE-150, Z = 150 Ω	BN 668/21
	TKSE-600, Z = 600 Ω	BN 668/22

Attenuation networks

Impedance	Connector	Insertion loss for d.c. voltage	Order No.
75 Ω	1.6/10 (F) – 1.6/10 (M)	9.03 dB ± 0.15 dB	BN 594/1
		19.03 dB ± 0.20 dB	BN 594/2
50 Ω	N-Conn. (F) – N-Conn. (M)	10.79 dB ± 0.15 dB	BN 594/3
		20.79 dB ± 0.20 dB	BN 594/4

"T" pads

Impedance	Connector	Order No.
75 Ω	(IEC 75-7) 1.6/10 (F)	BN 595/1
50 Ω	Type N-Connector (F)	BN 595/2

Adaptors

Impedance	Connector		Return loss coefficient at 100 MHz/300 MHz	Order No.
75 Ω	1.6/10 (F) to	BNC (M)	0.02/0.04	S 391
		BNC (F)		S 392
		2.5/6 (M)	0.03/0.05	S 393
		2.5/6 (F)		S 394
		1.6/5.6 (M)	0.015/0.03	S 395
		1.6/5.6 (F)		S 396
		WE 440 A (M)	0.01/0.02	S 397
		WE 558 A (F)		S 398
		WE 358 A (M)	0.01/0.02	S 399
		WE 470 C (F)		S 400
50 Ω	N-Conn. (F) to	BNC (M)	0.01/0.025	S 407
		BNC (F)		S 408
		4.1/9.5 (M)	0.01/0.01	S 409
		4.1/9.5 (F)		S 410
		7/16 (M)	0.01/0.01	S 18
		7/16 (F)		S 17
		C-Conn. (M)	0.01/0.015	S 411
		C-Conn. (F)		S 412

Couplings

75 Ω	1.6/10 (M) – 1.6/10 (M)	0.01/0.015	S 390
50 Ω	N-Conn. (M) – N-Conn. (M)		S 406

Key for abbreviation: (M) = male ; (F) = female

ORDERING INFORMATION

For reprints of this technical bulletin: Order Technical Bulletin 501-EPM-1. (Small quantities available at no charge.

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